Pronghorn Antelope Population and Habitat Management in the Northwestern Great Basin Environments

LIB MP

IN REPLY REFER TO

United States Department of the Interior

6501
(N-930.1)

BUREAU OF LAND MANAGEMENT

Nevada State Office
300 Booth Street
P.O. Box 12000
Reno, Nevada 89520

D-100
D-101
D-500
D-501
D-510
D-530
D-540
D-550
D-400 I
D-401
D-402
D-410
D-420
D-430
D-440
D-450
D-480
D-200
D-201
D-210
D-220
D-230
D-240 I
UB I

Information Memorandum No. NV-81- 59
Expires 9/30/82

APR 6 1981

To: All State Directors, except Alaska

From: State Director, Nevada

Subject: Technical Information

During the 1980 BLM Wildlife Workshop held in Reno, efforts were accomplished to improve procedures to forward technical wildlife information to BLM Field Offices. Thus, when technical information is developed in the field, it will not be all shipped back to the Director's Office, and then again shipped back out to Field Offices. Instead, the technical information will be cleared through the Director's Office and then shipped directly to Field Offices. These procedures are for disseminating of technical information only and will not pertain to instructions or policy matters.

In conformance with these new procedures, enclosed are 5 copies of a technical publication entitled "Pronghorn Antelope Population and Habitat Management in the Northwestern Great Basin Environments." These guides provide wildlife habitat data of value to inventories, resource management plans, EARs and EISs.

If you need more copies, please contact the following source:

USDI, Bureau Land Management
c/o University of Nevada
Renewable Resource Center
1000 Valley Road
Reno, NV 89512
Com: 702-784-4600
FTS: 470-5779

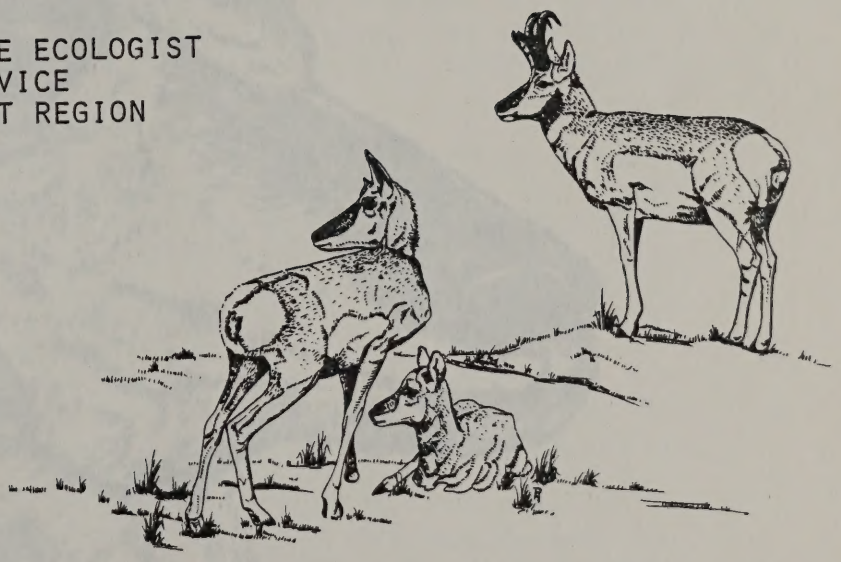
Associate

1 Enclosure
✓Encl. 1 - IAC Guides (5 ea.)

Distribution
Director (855) 2 with 2 encl.
SCD (D-559A) 3 with 2 encl.
DM (CA-020) 1 with encl.

Pronghorn Antelope Population and Habitat Management in the Northwestern Great Basin Environments

PREPARED BY: HAL SALWASSER
REGIONAL WILDLIFE ECOLOGIST
USDA, FOREST SERVICE
PACIFIC SOUTHWEST REGION



MARCH 1980

THE INTERSTATE ANTELOPE CONFERENCE GUIDELINES
CALIFORNIA DEPARTMENT OF FISH AND GAME
NEVADA DEPARTMENT OF WILDLIFE
OREGON DEPARTMENT OF FISH AND WILDLIFE
USDA, FOREST SERVICE
USDI, BUREAU OF LAND MANAGEMENT
NATIONAL PARK SERVICE
FISH AND WILDLIFE SERVICE

Line drawings are by Pat Hansen

PREFACE

In 1960, federal and state agencies cooperating in the Interstate Antelope Conference (California, Nevada, and Oregon) adopted "Guide Lines for Antelope Management." They were published in the 1962 Interstate Antelope Conference Transactions with the admonition that, ". . . should any portion of these "Guide Lines" become outmoded, obsolete or unworkable, they be subjected to modification or revision to maintain optimum value." This paper constitutes a major revision of the original guidelines.

The revision was commissioned at the 1978 session of the Conference and was assigned to a committee chaired by Marvin Kaschke of the U.S. Fish and Wildlife Service. Committee members included Frank Grogan, Oregon Department of Fish and Wildlife; Jerry Page, U.S. Bureau of Land Management; Hal Salwasser, University of California, Berkeley; and Doug Thayer, California Department of Fish and Game. The committee drafted an outline for the new guidelines and directed the author to prepare a draft for the 1979 Conference. Agency comments on that draft were incorporated into this edition for final review in Spring 1980. Karen Shimamoto assisted on the initial draft. Chris Maser and Jim Yoakum thoughtfully reviewed the manuscript. Jim Yoakum and Peg Evers edited the final publication. Kathy Wong and Marcia Dumpit prepared the final manuscript.

While the current revision was under preparation, the author became aware of three overviews on pronghorn management; the excellent work "Guidelines for the Management of Pronghorn Antelope" (Autenrieth 1978) published in the Proceedings of the Eighth Biennial Pronghorn Antelope Workshop (Barrett 1978), the proposed "Pronghorn Habitat in Managed Rangelands" Chapter in the series "Wildlife Habitats in Managed Rangelands - The Great Basin in Southeastern Oregon (Thomas and Maser, in progress), and the paper "Range/Wildlife Interrelationships--Pronghorn Antelope (Kindschy et al. 1978), a forerunner to the aforementioned chapter, which was published in Barrett (1978). Much of their information is incorporated into this paper.

The Interstate Antelope Conference Guidelines is distinct in its attention to herd and habitat management planning. Further, it has been designed to serve both as a guidelines for the Conference and as a "Specific Management Document - Selected Species Pronghorn Antelope" of the California Wildlife Habitat Relationships Program (Salwasser et al. 1980).

Information in this paper has been synthesized from published literature, unpublished reports, theses, dissertations, and the personal experience of pronghorn biologists and managers. It covers both population and habitat ecology and management and presents management guidance in the context of a holistic or ecosystem perspective on northwestern Great Basin natural resources management.

Pronghorn management must be based on specific location objectives for pronghorn as well as other wildland resources. Management actions thus

become an integral part of the multiple-resource prescriptions applied to the land. Standards and guidelines presented here are based on our current understanding of pronghorn life history and ecology. As with the original guidelines of this Conference they should be revised as new information or management situations warrant.

Pronghorns are usually censused using aircraft. (Photo by Joe Van Wormer)

TABLE OF CONTENTS

Typical sagebrush-steppe pronghorn habitat in eastern Oregon. (Photo by author)

INTRODUCTION

Pronghorn management includes 1) direct actions-purposeful manipulations of population structure and dynamics, and 2) indirect actions-manipulations of the environment (ecosystem) in which pronghorn and man are integral parts. The latter actions, which can include predator management, livestock grazing, vegetation conversions, fencing, ORV management, and many other activites, are not always purposeful with regard to pronghorn. They, nevertheless, have an influence on pronghorns.

Because this paper is intended for use in pronghorn management, management guidelines precede the section on life history and ecology. Emphasis is on the development of resource management plans, whether they be herd plans or multiple-resource plans. It is assumed that such plans will be developed by interdisciplinary teams using the NEPA or similar process. Specific aspects of a management plan, and technical methods for implementation and monitoring are presented.

The seasonal life history and ecology section is a synthesis of current understanding of pronghorn ecology. It is included to provide a rationale for the management guidelines and an ecologically-based literature review on the species.

1.0 PRONGHORN MANAGEMENT UNIT PLANNING

1.1 Defining the Pronghorn Management Unit

1.11 Population Definition

To discuss, evaluate, or manage a population, that population must be defined. Populations are subsets of the species. They may be geographically distinct groups of animals and relatively easy to define as a population, or as is occasionally the case with pronghorns, the population may exist only as an administrative unit because of a high degree of intermixing between animals of distinct geographical areas. Ideally, the delimitation of population boundaries should be based on functional characteristics related to gene flow (Smith et al. 1976), or as Caughley (1977a:4) put it, "A group of interbreeding individuals having little or no contact with other such groups." These are basic biological standards.

Cole (1957) offered the following working definition of the lower limits that constitute a population, "a biological unit at the level of ecological integration where it is meaningful to speak of a birth rate, a death rate, a sex ratio and age structure in describing the properties of the unit." It is also meaningful to identify a size, density, social structure, seasonal distribution, and movement pattern of the unit. These and other actual characteristics of the unit are known as population parameters. Our estimates of the characteristics are called population statistics (Caughley 1977a).

An important point in delimiting population boundaries is to place them so movement across boundaries is minimized. Emigration and immigration are difficult to quantify. If they occur and go undetected, they can cause severe perturbations in population statistics and could cause erroneous management decisions. One method of minimizing statistical error due to dispersal is to make the herd unit areas as large as possible, thereby reducing the probability of significant movements across herd boundaries.

Management constraints are also important in defining populations. Such things as inventory and management feasibility, knowledge of population characteristics, and the boundaries of other resource management units should be considered. Whether the management unit is called a pronghorn herd or a pronghorn management unit is not a critical issue. It is important that the unit has a biological basis, that it minimizes dispersal between units, and that it facilitates sensitive management of the population and its environment.

1.12 Population Description

To provide a starting point for management and an understanding of what has happened in the past, information should be presented in tables, figures, or both:

i) Geographic boundary of the unit (map)

ii) Population size: history and current status (figure and table)

iii) Harvest records (figure and table)

iv) Age structure and sex ratio (figures and tables)

v) Documentation of historic, current, or periodic disease, parasite, or predator problems

vi) Synopsis of research projects on the population

vii) Simulation model of population dynamics to show management options

1.13 Range Description

The total range of a population is the sum of all of its seasonal ranges, the entire area occupied by a population during its annual cycle. To set the range perspective, information, presented in tables, figures, and maps is useful:

i) Topographic, climatic, and soil characteristics of the range

ii) Major plant communities, identified by vegetative dominance and structural characteristics (use the most current acceptable vegetation classification system)

iii) Animals that commonly interact with pronghorns, e.g., predators, competitors, cooperators

iv) Availability of important forage plants (organized by season)

v) Distribution of natural and developed water

vi) Current and historical livestock uses; species, numbers, seasons, grazing intensity (incl. feral horses)

vii) Fence locations and types (allotment fence map)

viii) Fire history (map showing areas and dates)

ix) Vegetative manipulations (map showing areas and dates)

x) Location and summary of range inventories (tables)

xi) Synopsis of research projects on the range

xii) History of agricultural and other developments (include map to show pattern of intermingled private lands)

1.14 Seasonal Ranges Designation

The entire area occupied by an animal during its lifetime is important to the existence of the individual. There will be some areas, however, that receive heavier use by members of the population. Such areas have received a myriad of labels, e.g., core area, migration corridor, concentration area, etc. In general such an area receives special use by pronghorns because it provides essential habitat elements in greater quantity or quality than do other parts of the range. For example, it may be the only area where pronghorns can find suitable winter habitat, or it may be a traditional route between home ranges. In any case, these areas warrant special management consideration. Their location, size, shape, and distribution should be indicated on maps. It may be necessary to apply special manage-ment prescriptions to such seasonal ranges. The following should be designated (Figure 1-1):

i) Winter ranges

ii) Migration corridors and holding areas (for migratory populations)

iii) Fawning areas

iv) Summer ranges

Seasonal range designation should be based on sound field work. Aerial surveys of seasonal distribution, areas of higher densities, or migration movements are useful. Radio-telemetry studies may be needed in some cases.

1.15 Factors Regulating Pronghorn Populations

Understanding the environmental factors affecting population ecology is crucial to successful management. From analysis of the population, range status and history, and basic pronghorn ecology, it should be possible to identify those components of the local

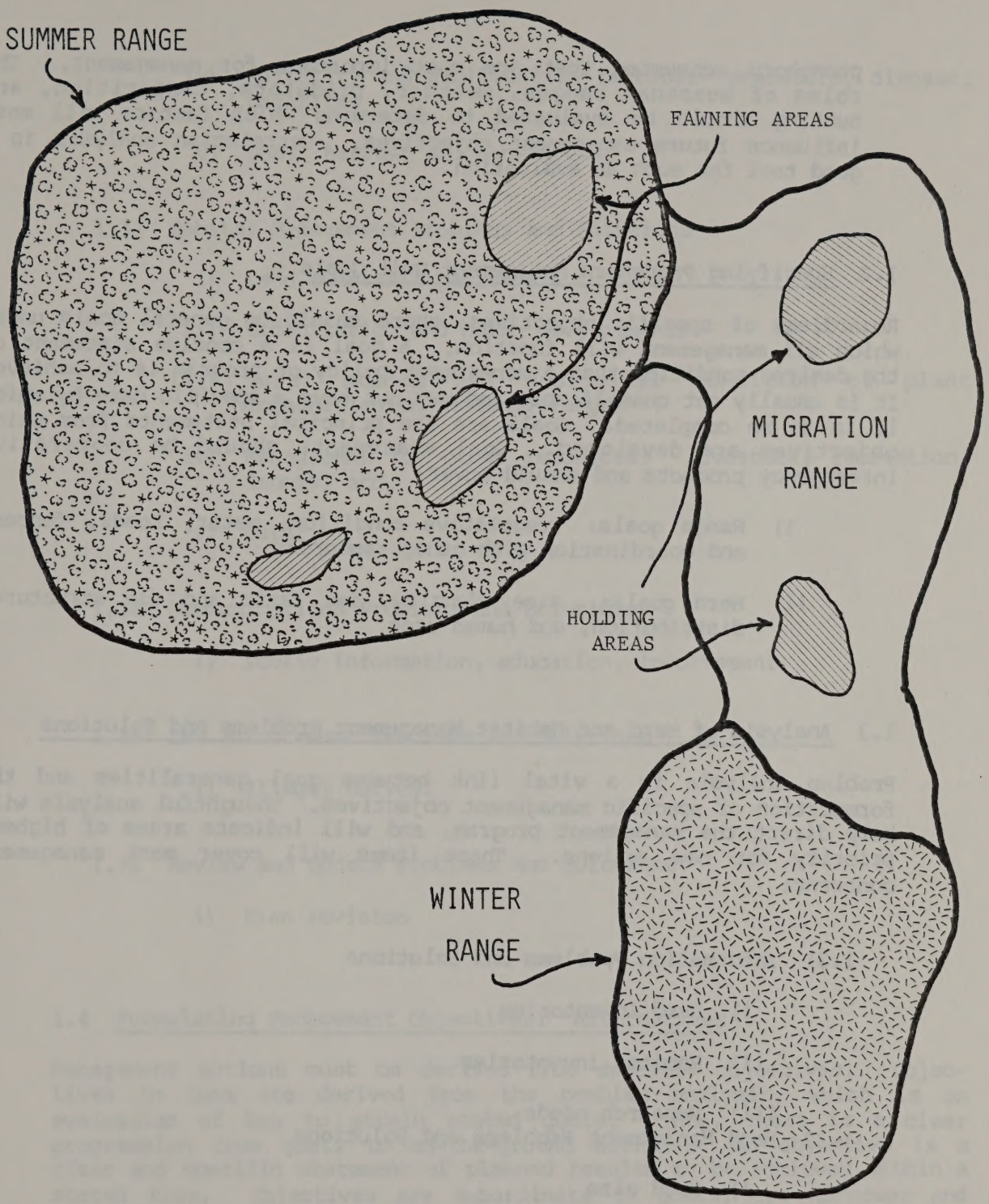


Figure 1-1. An Example of Pronghorn Seasonal Range Designations.

pronghorn ecosystem that are most important for management. The roles of seasonal ranges, weather, predators, competition, and hunting should be evaluated to determine which factors will most influence future management objectives. Correlation analysis is a good tool for such an evaluation.

1.2 Specifying Pronghorn Management Unit Goals

Regardless of specific objectives, there should be general goals under which all management will function. A goal is a concise statement of the desired condition that a management policy or program is to achieve. It is usually not quantifiable and may not have a specific date by which it is to be completed. Goals are the principal statements from which objectives are developed. Goal statements should be cooperative interagency products and should cover:

i) Range goals: vegetative condition, water, roads, fences, and coordination with other resources

ii) Herd goals: size, density, sex ratio and age structure, distribution, and human uses

1.3 Analysis of Herd and Habitat Management Problems and Solutions

Problem analysis is a vital link between goal generalities and the formulation of specific management objectives. Thoughtful analysis will help direct the management program, and will indicate areas of highest priority for new actions. These items will cover most management concerns:

1.31 Information Problems and Solutions

i) Herd inventories

ii) Habitat inventories

iii) Research needs

1.32 Herd Management Problems and Solutions

i) Herd size

ii) Sex ratio and age structure -- recruitment

iii) Distribution and dispersal

iv) Mortality and debilitation factors: predators, disease, parasites

v) Use: harvest and non-harvest

1.33 Habitat Management Problems and Solutions

i) Land ownership patterns

ii) Urbanization and human developments

iii) Seral stages and ecological condition of plant communities on seasonal ranges

iv) Management for other resources: livestock, recreation, fences, etc.

v) Water

1.34 Communications Problems and Solutions

i) Public information, education, involvement

1.35 Law Enforcement Problems and Solutions

i) Illegal harvest

1.36 Review and Update Problems and Solutions

i) Plan revision

1.4 Formulating Management Objectives: Alternatives

Management actions must be derived from specific objectives. Objectives in turn are derived from the problem analysis, which is an evaluation of how to attain stated goals. Thus, there is a clear progression from goals to on-the-ground actions. An objective is a clear and specific statement of planned results to be achieved within a stated time. Objectives are subordinate to goals, are narrower and shorter in range, and have an increased probability of attainment.

As with goals, objectives should be developed through coordination by state and federal agencies responsible for land and animal management and with private land owners where significant portions of the range are

in such ownerships. Public land and resource management planning involves decisions about various resources. A reasonable set of pronghorn management alternatives (objectives and action plans) will be needed for such planning.

Each alternative must clearly state its objectives, management actions, costs, trade-offs, and benefits.

1.41 Criteria for Objectives

Objectives should:

i) State the identity, nature, and depth of the problem that is to be addressed

ii) Be stated explicitly, concisely, and completely, i.e., quantitatively

iii) Be realistic and relative to the specific management situation

iv) Lead to a step-by-step specification of the actions needed

v) Be measurable

vi) Be attainable

1.42 Elements of Alternatives (Figure 1-2)

i) Herd objectives (or anticipated management actions)

a) Herd size or density

b) Sex ratio and age structure

ii) Habitat elements needed to meet herd objectives: acres, sites, and prescriptions

iii) Use objectives and strategy

iv) Objectives for alleviating acute mortality problems

v) Communication actions

vi) Inventory actions (monitoring)

vii) Review and update process

viii) Research needed

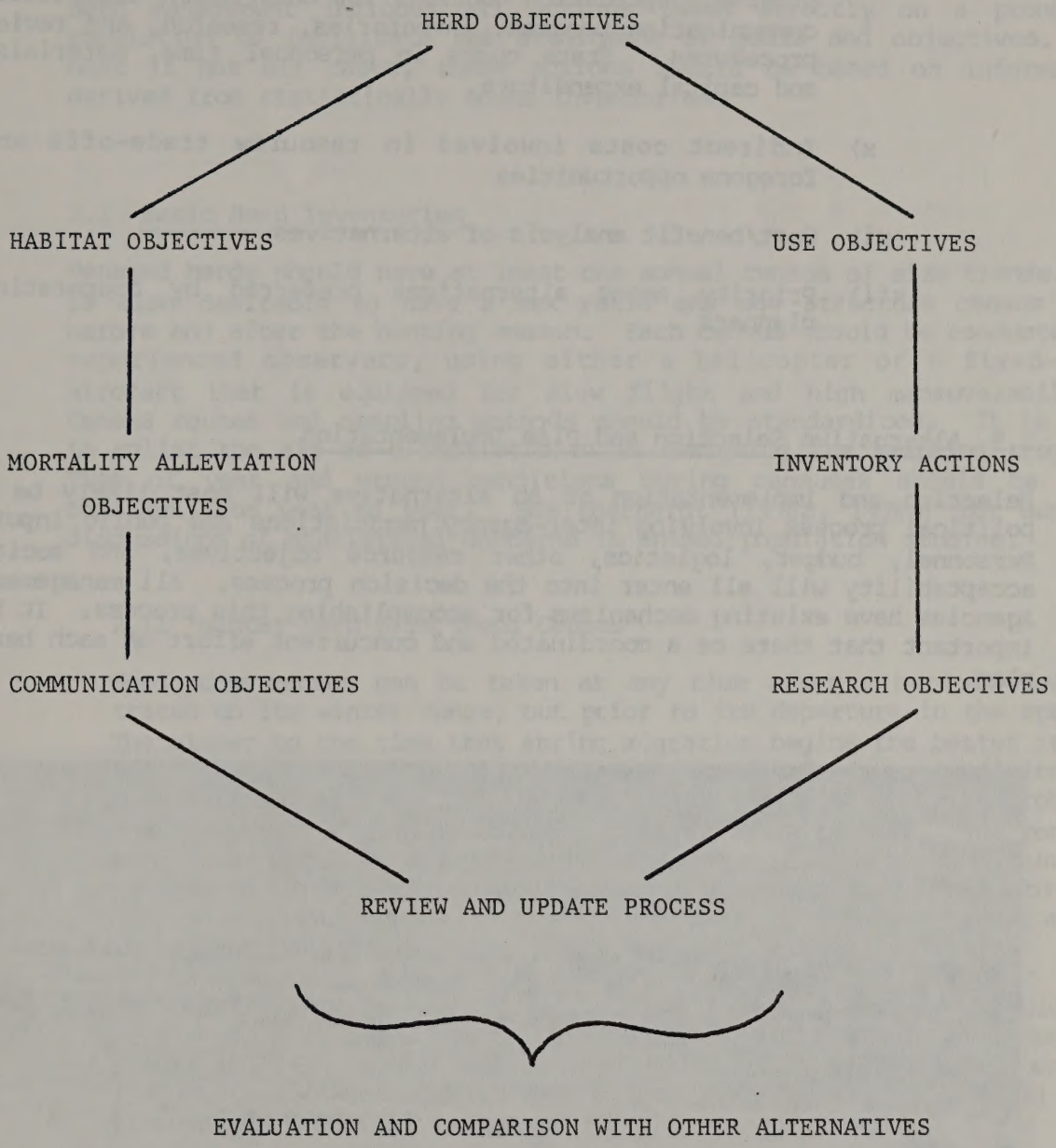


Figure 1-2. Elements of a Comprehensive Pronghorn Management Alternative.

ix) Direct annual and long-term costs of herd and habitat management, alleviation of mortality, operating the use program, depredation control, law enforcement activities, communication program, inventories, research, and review procedures. State costs in personnel time, materials, and capital expenditure.

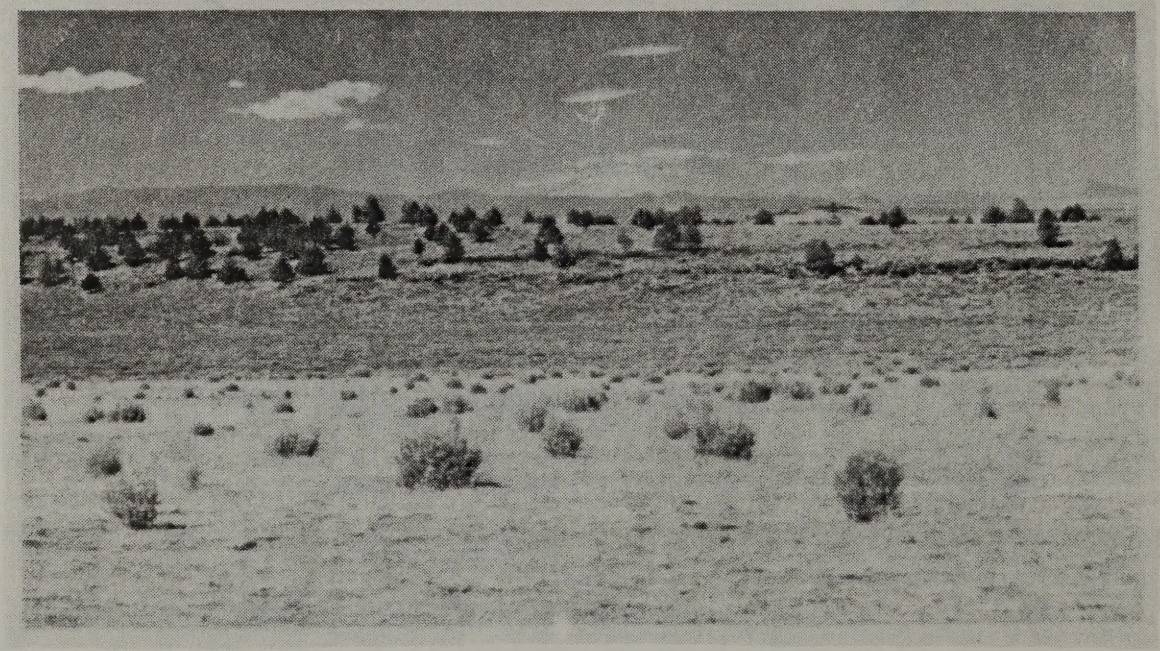
x) Indirect costs involved in resource trade-offs and foregone opportunities

xi) Cost/benefit analysis of alternatives

xii) Priority among alternatives preferred by cooperating planners

1.5 Alternative Selection and Plan Implementation

Selection and implementation of an alternative will most likely be a political process involving inter-agency negotiations and public input. Personnel, budget, logistics, other resource objectives, and social acceptability will all enter into the decision process. All management agencies have existing mechanisms for accomplishing this process. It is important that there be a coordinated and concurrent effort on each herd plan.



The herbaceous flat in the foreground is used by Northeastern California pronghorns in the spring. (Photo by author).

2.0 HERD MANAGEMENT TECHNIQUES

Herd management includes all actions taken directly on a pronghorn population to facilitate the attainment of goals and objectives. In most if not all cases, these actions should be based on information derived from statistically sound inventories.

2.1 Basic Herd Inventories

Managed herds should have at least one annual census of size trends. It is also desirable to have a sex ratio and age structure census both before and after the hunting season. Each census should be conducted by experienced observers, using either a helicopter or a fixed-wing aircraft that is equipped for slow flight and high maneuverability. Census routes and sampling methods should be standardized. It is wise to enlist the aid of a statistician in designing the sampling program. Time of year and ground conditions during censuses should be held constant from year to year. See Eberhardt (1978a, 1978b) for general discussions of statistical concerns in animal population studies.

2.11 Winter Herd Size Trend Census

Herd size census can be taken at any time after a herd is concentrated on its winter range, but prior to its departure in the spring. The closer to the time that spring migration begins the better is the estimate of post-winter herd size. Some herds have traditionally been censused in late January and early February, which is probably too early to get a valid count of post-winter herd size. The consistency of census methods and the historical ease of counting pronghorns in mid-winter may, however, maintain this date for the herd size trend census. This census has its greatest value as an index of herd size.

On small herds, as complete a count as is possible should be attempted. On large herds, a stratified sampling approach may be justified. See Siniff and Skoog (1964), Jolly (1969), Bell et al. (1973), Norton-Griffiths (1973), and Caughley (1974, 1977b) for discussions on aerial censuses.

2.12 Pre-hunt Sex Ratio and Age Structure Census

A pre-hunt census has usually been taken during late July and early August when fawns are at heel and readily identifiable as fawns. Its greatest value is to obtain an estimate of potential recruitment through the post-natal period. The value in estimating a pre-harvest buck to doe ratio is low, however, and depends on the completeness of

the census (Autenrieth 1978). If less than 50 percent of the herd is included in the count, the estimated buck ratio is probably subject to a high degree of sampling error. Care must be taken to cover all range areas that may have bachelor male bands and non-territorial males, as well as the traditional male territories.

It may be possible to determine the locations and extent of male territories by putting the locations of single males and males with doe/fawn groups on a range map. Several years of such mapping would probably be necessary. If territories exist on the range, this information would be useful in identifying the best pronghorn summer habitats. See Kitchen (1974) for a discussion of the importance of male territories.

It may be of value to attempt to distinguish yearling males in the census. This would give an index of actual yearling recruitment to the herd. One must specify an assumption about sex differential mortality during the first year of life in order to estimate recruitment from the yearling male count. This assumption should be based on research findings. Identification of fawns, does (yearling and older), and bucks (yearling and older) is the standard approach taken during both a pre-harvest and post-breeding census. Information should be obtained on:

i) Sample size

ii) Number of bands in the sample (pre-breeding only)

iii) Number of bachelor male bands (pre-breeding only)

iv) Number of suspected territorial males (pre-breeding only)

v) Number of nursery bands (pre-breeding only)

vi) Males (Bucks) per 100 females (Does) (BB:100DD)

vii) Juveniles (Fawns) per 100 females (Does) (FF:100DD)

2.13 Post-harvest/Post-breeding Sex Ratio and Age Structure Census

Post-breeding censuses should be taken after the harvest season and after the end of breeding activities. October is the best time. All aspects of the census would be similar to the pre-harvest census. The main value of this census is to provide more accurate information on the buck to doe ratio (Bear 1969). This is based on the assumption that most males will be associated closely with females and fawns during this period. The information also provides a later index of potential recruitment to the herd. If only one herd

structure census can be taken, it should be taken after breeding activities are over. If taken in addition to a pre-harvest census, it will provide a data base for change-in-ratio methods for estimating herd size. See Paulik and Robson (1969) or Seber (1973) for discussions of these methods.

2.14 Harvest Record

An accurate count of the number, sex, and age of pronghorn removed from the population through legal harvest is vital to population management. This is currently accomplished on most herds through a mandatory return of harvest permit tags and check-in of animals taken. It should be continued where now practiced and implemented on all other managed herds.

2.15 Simulation Modeling

Simulation is a relatively new tool in the inventory field. It can be used to synthesize such information as herd size trend, sex and age structures, harvest information, and other population parameters (such as reproductive rates) to yield a comprehensive model of herd dynamics. Computerization allows assessments of herd performance and predictions of herd responses to management actions. See Salwasser and Pojar (in prep.) for a discussion of simulation modeling in pronghorn management.

2.2 Herd Protection

Early literature stressed the need for protecting pronghorn herds from hunting, harassment, and loss of habitat. Many herds no longer require complete protection from hunting. Where pronghorns are being re-introduced to historic ranges, however, there may be a need to protect them from hunting and human harassment during the establishment period. All herds need protection from human harassment and habitat loss.

2.3 Harvest

Annual harvest depends on the goals and objectives for a particular herd. What constitutes a legal harvest age and sex should be determined by the goals and objectives for each management unit.

2.31 Hunting Season Dates

A hunting season should be held during the period late August through

early September, when animals are in prime physical condition. Harassment during breeding activities is avoided by holding the harvest prior to the breeding period. Stress to lactating females is also minimized by harvest during this period. And, maximum horn growth in males has occurred. Post-breeding season hunts should be held only as a last resort, or to take advantage of special management opportunities. Following the rut, animals are preparing for winter. Human harassment at that time will cause additional depletions of the tissue reserves needed to meet winter stresses.

2.32 Buck Ratio

It is traditional to consider a post-harvest breeding ratio of 1 buck per 5 does to be adequate for optimum breeding success, but there is little evidence to support this. Maximum breeding in mule deer can occur with as few as 1 breeding age buck per 20 breeding age does (Salwasser 1979). A post-harvest buck ratio of 20BB:100DD for pronghorns is a biologically safe post-harvest objective. It may not be the biological minimum for complete breeding. Higher post-harvest buck ratios may be needed where "trophy" hunts are an objective.

2.33 Tags

Demand for pronghorn hunting usually exceeds the supply of legal animals. Harvest should therefore, be apportioned by application for special tags. Each successful applicant should be required to return his/her tag regardless of hunting success. All hunters should indicate whether they killed an animal and the location of the kill.

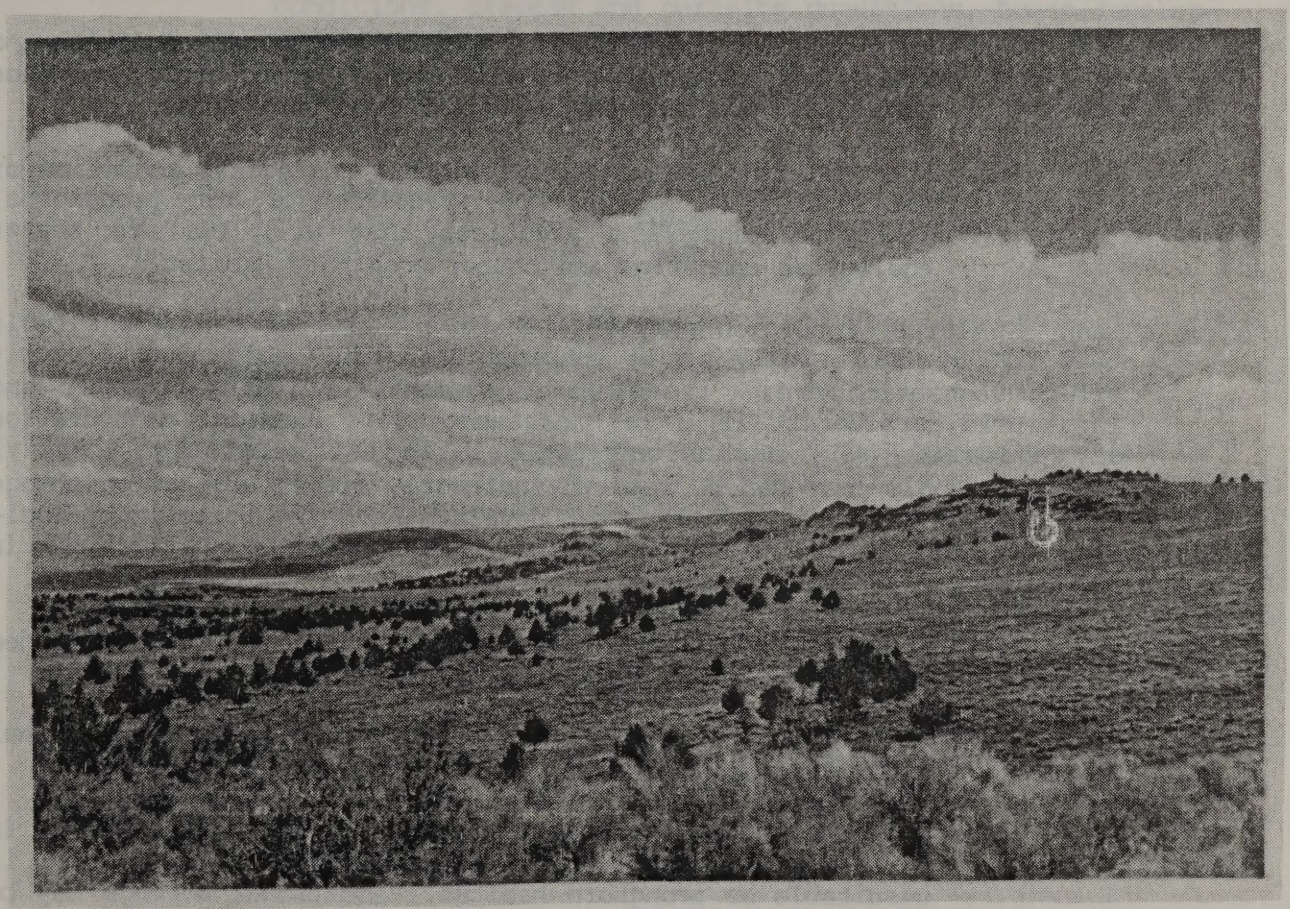
2.34 Modeling for Harvest Strategy

Simulation modeling is a valuable tool for determining those harvest strategies suitable for achieving herd goals and objectives. Where simulation models have been constructed from sound inventory data, accurate estimates of previous harvests and valid estimates of reproduction and mortality rates, the models can be used to predict population response to the removal of specific numbers of the various sex and age classes from the population. Every effort should be made to use valid simulation models in developing a harvest program for managed pronghorn herds.

2.4 Depredation Control

Pronghorns cause depredation problems on private lands in some areas. Each state has its own policies regarding depredation. In general,

problem animals should be used as the stock for planned re-introductions on historic ranges. They should not be transplanted to ranges already stocked with pronghorns, since that is likely to exceed the pronghorn carrying capacity of those ranges. As an alternative to transplanting problem animals, special hunts can be held to reduce the number of animals on private lands to an acceptable level.



The open south and west slopes are preferred pronghorn habitat in spring. (Photo by author).

3.0 HABITAT MANAGEMENT TECHNIQUES

3.1 General Principles and Assumptions

It would be redundant to include a detailed discussion of all aspects of pronghorn habitat management here. The topic has been thoroughly and adequately covered by Yoakum (1972, 1974, 1975, 1978), Autenreith (1978), and Kindschy et al. (1978). It is of most value to highlight the significant conclusions and recommendations of these and other literature on pronghorns.

Yoakum's (1978) principles of managing vegetation for pronghorns provide a general operating philosophy:

i) When existing vegetation is in good ecological condition and meets the seasonal requirements of pronghorns, continue management programs that maintain such conditions.

ii) When existing vegetation is in poor ecological condition or fails to meet one or more requirements for pronghorns, implement management practices that will lead to better ecological condition and better pronghorn habitat.

When the latter condition prevails, there are several management tools that can be used singly or in combination. The tools that directly affect vegetation are: i) animal management, including domestic and large wild herbivores, ii) fire management, iii) chemical manipulation of vegetation, iv) mechanical manipulation of vegetation, and v) seeding. Tools that can be used to indirectly affect vegetation change include: i) fencing, and ii) water development. The following principles are recommended when considering any of these tools for use in resolving habitat deficiencies:

i) Projects, other than animal management, should be planned and carried out in accordance with Plummer et al. (1968).

ii) Projects should result in a habitat that meets the seasonal needs of pronghorns.

iii) Not more than 25 percent of any seasonal range should be in a vegetative manipulation or developmental stage that is unsuitable as pronghorn habitat. Additional acreage may be restored only after a treated area is reinhabited by pronghorn.

iv) Projects should be carried out with a minimum of physical barriers to pronghorn movements, e.g., fences and canals.

v) Projects, other than reduction in domestic livestock or feral horse use, should not be done on areas currently used successfully for fawning.

The following guidelines for habitat management are based on five fundamental assumptions:

i) Pronghorn densities vary between ranges as a function of continuous interactions between the pronghorn population, the vegetative types on the range, the characteristics of those vegetative types (vigor, structure, and floristics), the mosaic of different vegetative types, the amount of competition with other herbivores, the nature of the predator-prey system, availability of water, annual weather conditions, disease and parasite conditions, human developments, such as roads, fences, and buildings, and human activities, including hunting and other recreation. In other words, pronghorn density regulation is a multi-factor system.

ii) The relative importance of the above factors in pronghorn ecology can change naturally over time, or can be purposefully changed by man.

iii) Native ranges containing a high floristic diversity of grasses, forbs, and low growth form shrubs best meet pronghorn habitat needs.

iv) Intentional, accidental, or natural actions that manipulate vegetation can benefit pronghorns if the actions change undesirable vegetative characteristics to conditions favored by pronghorns.

v) Pronghorns evolved in a symbiotic relationship with other large grazing mammals. They are therefore, likely to be compatible with some density of domestic livestock on their ranges.

Habitat management activities and allocations of habitat resources among competing uses should be tied directly to the pronghorn population goals and objectives.

3.2 Habitat Inventories

As in herd management, actions taken to improve pronghorn ranges, or compromises made with other resources, must be based on information that the actions are needed. There are many ways in which such information can be obtained. Information on habitat conditions should be obtained

from multi-resource inventories. Although not widely implemented at present, they will probably become more common in the future. A well-designed sampling system can yield vegetative information that will satisfy the needs for livestock, wildlife, and vegetation management.

In establishing multi-resource inventories that will consider pronghorn habitat, information should be collected on:

i) Percent cover of shrubs, forbs, and annual and perennial grasses.

ii) Species composition and frequency of plants in the herbaceous and shrub layers.

iii) Form and age class of important shrubs.

iv) Vertical profile of habitat structure.

Such information relates to habitat management models; it should be specific to vegetative types and phases, and apply separately to each seasonal range. An average of all vegetative characteristics over all types and seasonal ranges is meaningless to management.

Knowledge of the amount and juxtaposition of different vegetative types on each seasonal range is necessary in planning habitat management. Aerial photos are essential in mapping and developing this information. It is recommended that each pronghorn range under intensive management have a vegetative type and phase map together with an analysis of acreages involved. Overlays for the map should identify seasonal pronghorn ranges and special-use sites.

3.3 Habitat Management Models

Evaluation of the condition of pronghorn habitat and development of habitat management prescriptions should use the Kindschy et al. (1978) models until local versions of basic habitat relationships have been developed. The models are reproduced in Figures 3-1 to 3-6.

3.4 Management of Domestic Livestock

Cattle, sheep, and horses are the principal domestic livestock that share pronghorn ranges. Their grazing impacts can be either positive or negative, depending on how the animals are managed. The following guidelines for livestock management apply to ranges in good ecological condition. They are designed to minimize conflicts and to use livestock as a positive tool to enhance pronghorn forage resources. Poor condi-

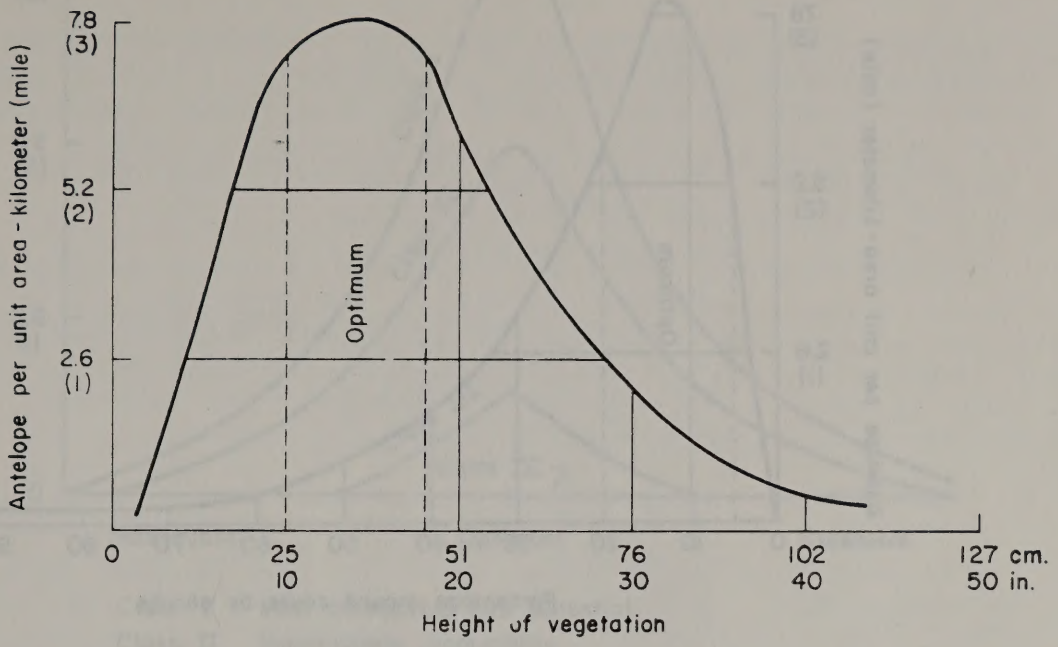


Figure 3-1. Vegetative height in centimeters (inches) in relation to antelope per square kilometer (mile) of sagebrush - steppe habitat (Kinschy et al. 1978).

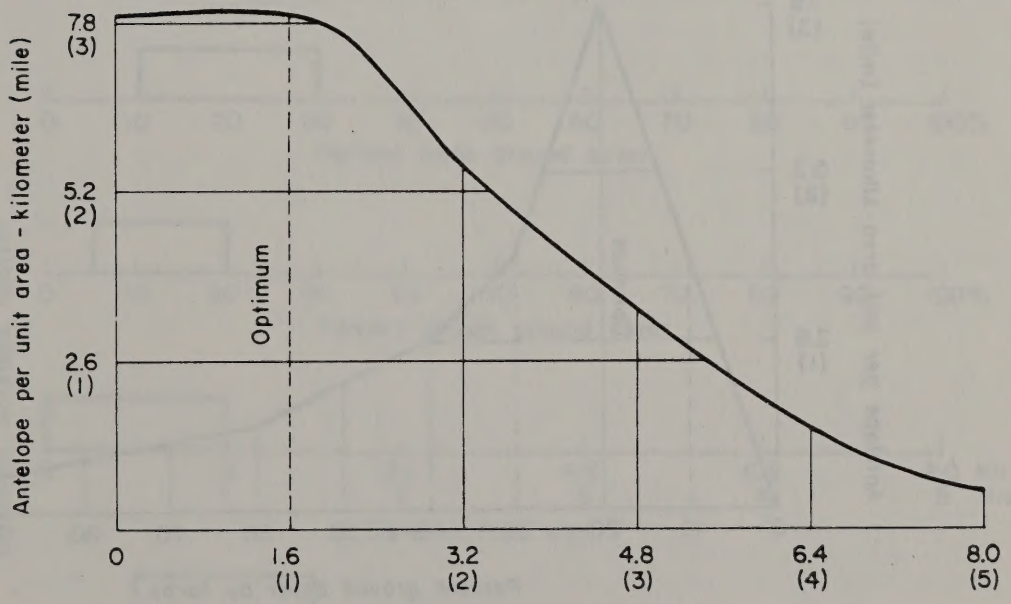


Figure 3-2. Distance to water in kilometers (mile) in relation to antelope per square kilometer (mile) of sagebrush - steppe habitat (Kindschy et al. 1978).

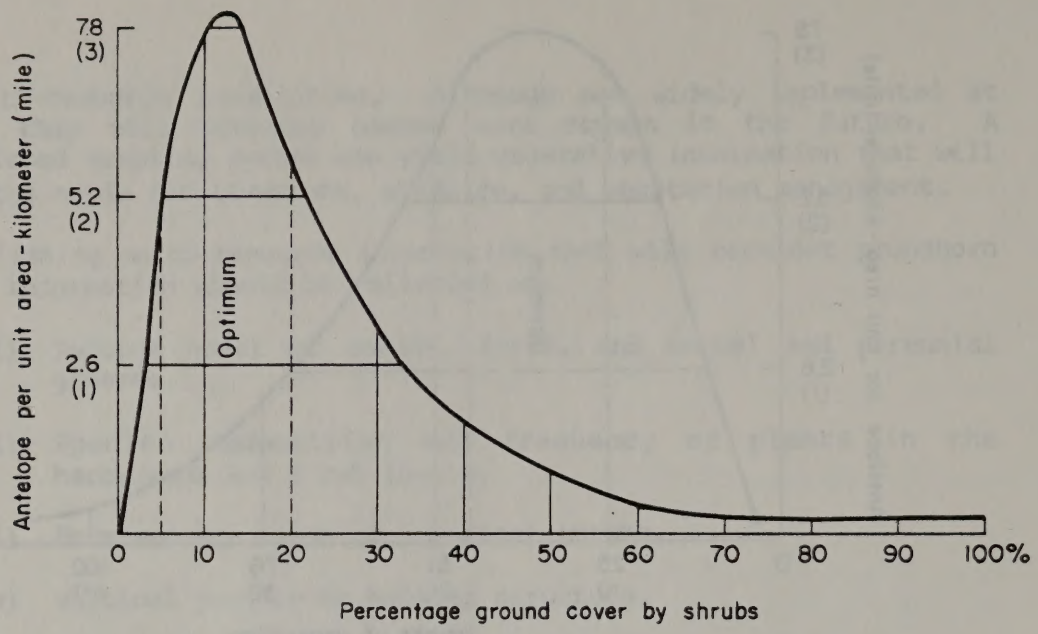


Figure 3-3. Percent of shrubs in ground cover in relation to antelope per square kilometer (mile) of sagebrush - steppe habitat. (Kindschy et al. 1978).

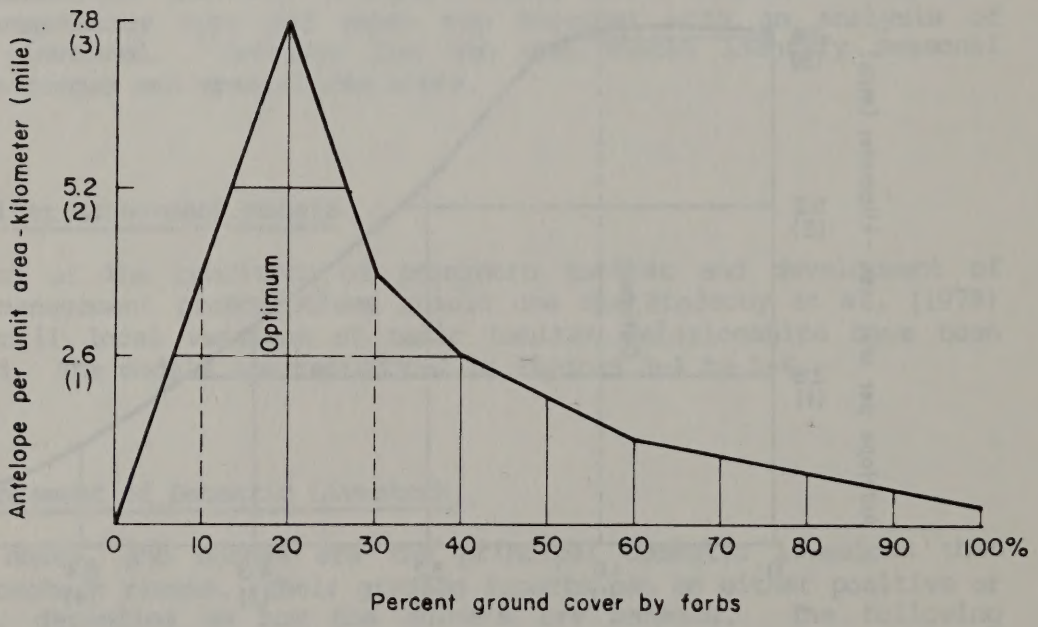


Figure 3-4. Percent of forbs in ground cover in relation to antelope per square kilometer (mile) of sagebrush - steppe habitat. (Kindschy et al. 1978).

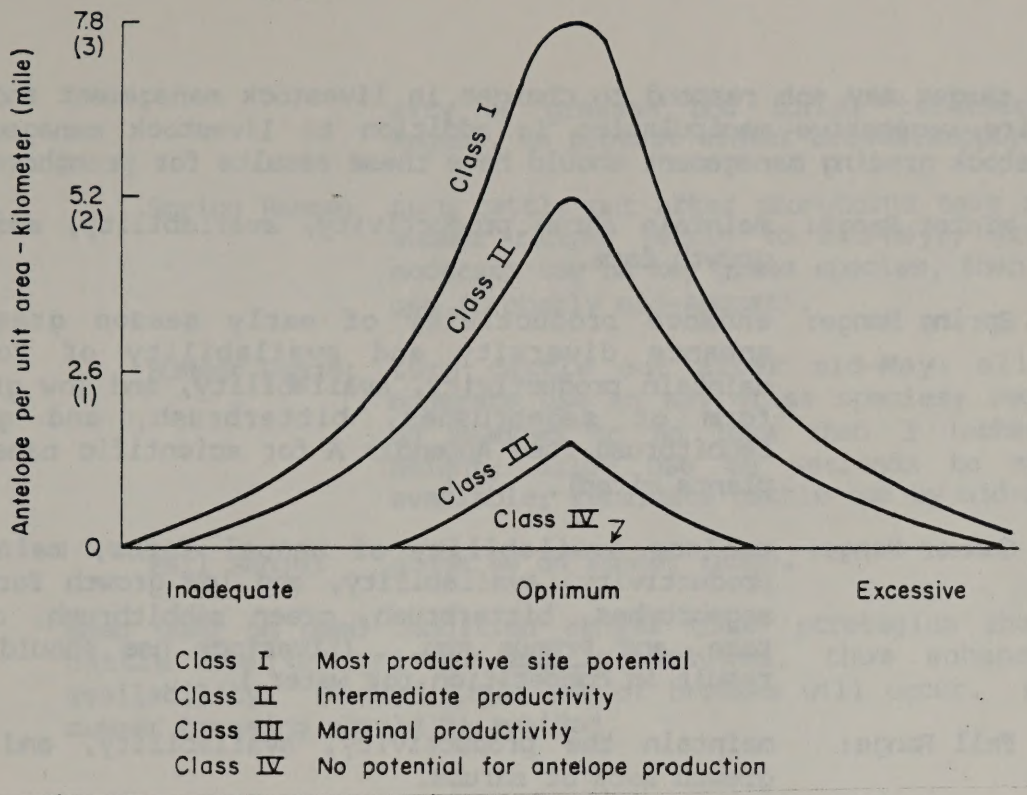


Figure 3-5. Potential production of antelope per unit area on extensive year long range in native condition in the sagebrush - steppe habitat (Kindschy et al. 1978).

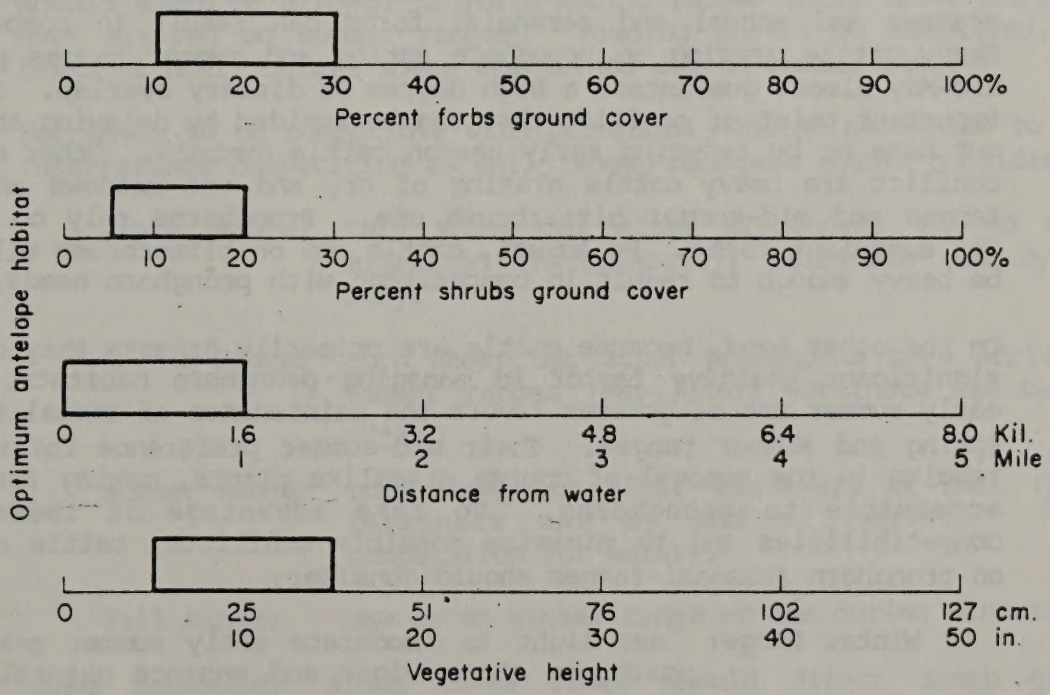


Figure 3-6. Optimum habitat characteristics for pronghorn antelope within the sagebrush - Steppe habitat (Kindschy et al. 1978).

tion ranges may not respond to changes in livestock management and may require vegetative manipulation in addition to livestock management. Livestock grazing management should have these results for pronghorn:

Winter Range: maintain shrub productivity, availability, and low growth form.

Spring Range: enhance productivity of early season grasses; enhance diversity and availability of forbs; maintain productivity, availability, and low growth form of sagebrushes, bitterbrush, and green rabbitbrush (see Appendix A for scientific names of plants cited).

Summer Range: prolong availability of annual forbs; maintain productivity, availability, and low growth form of sagebrushes, bitterbrush, green rabbitbrush, cliff rose, and Prunus spp. (Livestock use should not result in competition for water.)

Fall Range: maintain the productivity, availability, and low growth form of shrubs.

3.41 Cattle

Cattle are relatively compatible with pronghorns. Their diets are sufficiently different during late fall and winter that little overlap in forage use occurs. Nevertheless, the common use of spring grasses and annual and perennial forbs can result in competition. Heavy cattle grazing on pronghorn spring and summer ranges prior to mid-May almost guarantees a high degree of dietary overlap. It is an important point of conflict that can be avoided by delaying the turn-out date or by reducing early season cattle numbers. Other areas of conflict are heavy cattle grazing of dry and wet meadows on summer ranges and mid-summer bitterbrush use. Pronghorns rely on meadows for succulent forbs. By August, cattle use on bitterbrush will often be heavy enough to result in competition with pronghorn needs.

On the other hand, because cattle are primarily grazers they can be a significant positive factor in managing pronghorn habitats. Their early summer use of grasses favors the maintenance of annual forbs on spring and summer ranges. Their mid-summer preference for wetlands results in the removal of course grasslike plants, making forbs more accessible to pronghorns. To take advantage of these basic compatibilities and to minimize possible conflicts, cattle managers on pronghorn seasonal ranges should consider:

Winter Range: use light to moderate early summer grazing to maintain shrub vigor and enhance natural diver-

sity of grasses and forbs; terminate use by August, to protect winter browse supply.

Spring Range: turn cattle out after pronghorns have arrived on summer ranges (early to mid-May); graze up to moderate use on key grass species, then terminate use (probably mid-August).

Summer Range: turn cattle out after mid-May; allow up to moderate use on key grass species; regulate use on meadows to no less than 3 inches stubble height; allow use on wetlands to make forbs available; terminate cattle use by mid-September.

Fall Range: graze as on summer range.

When used on good condition ranges these strategies should focus cattle use on grasses and grasslikes, thus enhancing forb availability. Desired light use of browses will occur. Heavy late summer browsing should be avoided.

3.42 Sheep

Sheep have the highest degree of annual dietary overlap with pronghorns. In addition, there may be some social intolerance of sheep by pronghorns. Pronghorn winter ranges should not be grazed by sheep to the extent that significant use of browse occurs. Nor should sheep be allowed to graze spring ranges until after pronghorns have arrived on summer ranges. Fawning should be completed, with fawns at heel, before sheep are turned out on summer ranges.

For sheep to be compatible with pronghorn habitat needs and to avoid interference competition as well, sheep managers should consider:

Winter Range: turn sheep out after pronghorns are on spring migration (March-April); terminate use by late July.

Spring Range: turn sheep out after pronghorns have arrived on summer ranges (May-June); terminate use by late July.

Summer Range: turn sheep out after fawns are at heel (July); terminate use by end of August. (Avoid competition for water).

Fall Range: use as on winter range or use during winter.

Sheep management along these lines should direct sheep grazing towards grasses and away from forbs and browses.

3.43 Feral Horses

Feral horses live year-round on pronghorn ranges. They use mostly grasses and forbs, but will browse sagebrush during severe winters. Horses should either be eliminated or kept at low densities on pronghorn winter and spring ranges. High horse densities can result in serious competition for early spring grasses and forbs. Moderate horse densities on summer and fall ranges are probably compatible.

3.44 General Livestock Management Tips

In all cases of livestock management, the number of animals is as important as season of use (Heady 1975). The size of the range, its productivity, and the allocation of forage resources between wildlife and livestock will have a bearing on stocking rates. In addition to previous points these general principles should apply:

i) Avoid sheep trailing on spring migration routes and fawning areas from 15 days before pronghorn use to 15 days after pronghorn use.

ii) Avoid dense concentrations of all livestock in areas inhabited by pronghorns.

iii) Use herding and water distribution in lieu of extensive fencing for livestock management.

iv) Consider the seasonal life history and habitat needs of pronghorns and the guidelines for livestock management when designing grazing systems.

3.5 Fire Management

Natural wildfire was a major factor in keeping pristine vegetation in growth forms and stages favored by pronghorns. Vale (1975) noted that the pristine vegetation in much of the intermountain west consisted of dense stands of sagebrush. Heady and Bartolome (1977) concluded that fire was a most effective means of converting sagebrush stands to herbaceous vegetation in eastern Oregon. Burkhardt and Tisdale (1976) cited fire control as a principal factor in juniper expansion in southwestern Idaho. We can conclude from the literature and common experiences that without fire in the ecosystem many areas of pronghorn range would naturally progress toward dense sagebrush stands and an increasing frequency of junipers. These trends do not favor pronghorns. Hence, the reintroduction of fire on a prescribed basis should receive serious consideration in pronghorn habitat management.

Fire should not be used indiscriminantly. Areas of about 250 hectares (100 acres) or patchy fires that burn at different intensities on different sites are preferred. The intent of using fire for pronghorns should be to shift vegetative structure and floristics to more herbaceous cover, lower shrub height, and not more than 25 percent cover of shrubs. Complete eradication of shrubs is not desirable.

3.6 Mechanical Manipulation of Vegetation

Plowing and chaining are the principal mechanical methods of vegetative manipulation. Yoakum (1978) states that chaining was preferable to plowing, since plowing often eliminated highly preferred forbs. Chaining is less disruptive of the soil and herbaceous vegetation, and usually leaves some shrubs intact. Heady and Bartolome (1977) noted, however, that pronghorns made heavy use of plowed and seeded rangelands as early as the year following treatment. The use of plowed and seeded range will only persist if a diverse herbaceous stand becomes established. Monotypic grass stands are not desired. When designing either type of mechanical manipulation of vegetation, the general principles listed earlier should constrain the project.

3.7 Chemical Manipulation of Vegetation

Herbicide use in managing vegetation has created heated controversies. Chemicals can be effective in reducing shrub cover and, when heavily applied on large areas of pronghorn winter range, can be devastating to pronghorn habitat. On the other hand, application of 2,4-D on sagebrush ranges used during spring and summer by pronghorns apparently has been significant in the increase in pronghorns in southeastern Oregon (Yoakum, pers. comm.). As with any type of vegetative manipulation, the key to benefiting pronghorn habitat lies in the extent to which the treatment produces the habitat conditions needed by pronghorns during their season of residence on the site. When pronghorn habitat is unsuitable because of dense or tall shrubs, spraying can be a valuable tool in creating more herbaceous cover. Ideally, the spraying project should mimic the results of a patchy fire. A mosiac of areas of total shrub kill intermixed with areas of partial and no kill is desired. The use of herbicides is not inherently bad in pronghorn habitat management. Poor project design and lack of attention to pronghorn needs usually lead to negative results for pronghorns. Again, the principles listed earlier should constrain projects using chemical methods of vegetative management.

3.8 Seeding

Seeding is used in vegetative management when the site lacks the desired amount and species of native plants for natural establishment following burning, plowing, chaining, or spraying. Seeding a mixture of grasses and forbs has proven beneficial to pronghorns (Kindschy 1974, Heady and Bartolome 1977).

Large blocks of single plant species, such as crested wheatgrass, should be avoided. Yoakum (1978) recommended a seeding mixture containing a minimum of six species each of grasses, forbs, and shrubs. The mixture used on a particular project should be based on the site potential, nature of existing vegetation, and season of pronghorn use. For example, it may not be necessary to seed shrubs on a spring range unless the range is also used during other seasons. In general, a seeding should enhance the productivity and availability of grasses and forbs on the site. The Plummer et al. (1968) principles are especially applicable to seedings:

i) Changes in plant cover by the proposed measures must be determined to be desirable

ii) Terrain and soil types must be suited to the changes selected

iii) Precipitation must be adequate to assure establishment and survival of seeded plants

iv) Competition must be low enough to assure that desired species can be established

v) Only species and strains of plants adapted to the area should be planted

vi) Mixtures, rather than single species, should be planted

vii) Sufficient seed of acceptable purity and viability should be planted to assure establishment

viii) Seed must be covered sufficiently

ix) Planting should be done in the season of optimum conditions for establishment

x) The planted area must be adequately protected

3.9 Fences

Fences are necessary in the management of livestock. Appropriate fence design on pronghorn ranges has received considerable attention. Fences

can impose a barrier to movements and also can be a direct cause of injury and mortality. The consensus among pronghorn biologists is that pronghorns do not jump fences. Although some older pronghorns will learn to jump a fence, it is sufficiently rare that fence designs should not assume pronghorns will become conditioned to jumping.

In general, fences should not be constructed on pronghorn ranges. This is especially true of migration routes and areas where significant daily movements to and from water or feeding areas are common. When the construction or replacement of a fence is deemed necessary by range managers, wildlife biologists, or livestock operators for proper land management, the fence should be designed with the minimum amount of restriction to pronghorn movements. The Bureau of Land Management's 1737 policy on fencing provides guidelines for fencing on pronghorn ranges. The section on antelope ranges recommends:

i) Winter Ranges and Migration Corridors

Fencing for Cattle. Provide a three-strand fence with the top wire no higher than 97 centimeters (38 inches) above the ground and a barbless bottom wire at least 41 centimeters (16 inches) above the ground. (See Type I, Figure 3.7.)

Fencing for Sheep. Provide a four-strand fence with the top wire no higher than 81 centimeters (32 inches) above the ground and a barbless bottom wire at least 25 centimeters (10 inches) above the ground. (See Type II, Figure 3.7.)

Special Fence Types. Special fence types, e.g., buck and pole, and rail, suspension, etc., will be no higher than 84 centimeters (34 inches) above the ground, with a bottom gap at least 39 centimeters (12 inches) above the ground.

ii) Other Occupied Pronghorn Habitat:

Those fence types described above.

Fences Separating Adjacent Sheep and Cattle Use Areas. A four-strand fence with the top wire no higher than 97 centimeters (38 inches) above the ground and a barbless bottom wire at 25 centimeters (10 inches) above the ground. (See Type 3, Figure 3.7.)

The BLM policy document also provides additional tips on fence planning and should be consulted when any change in fencing is proposed.

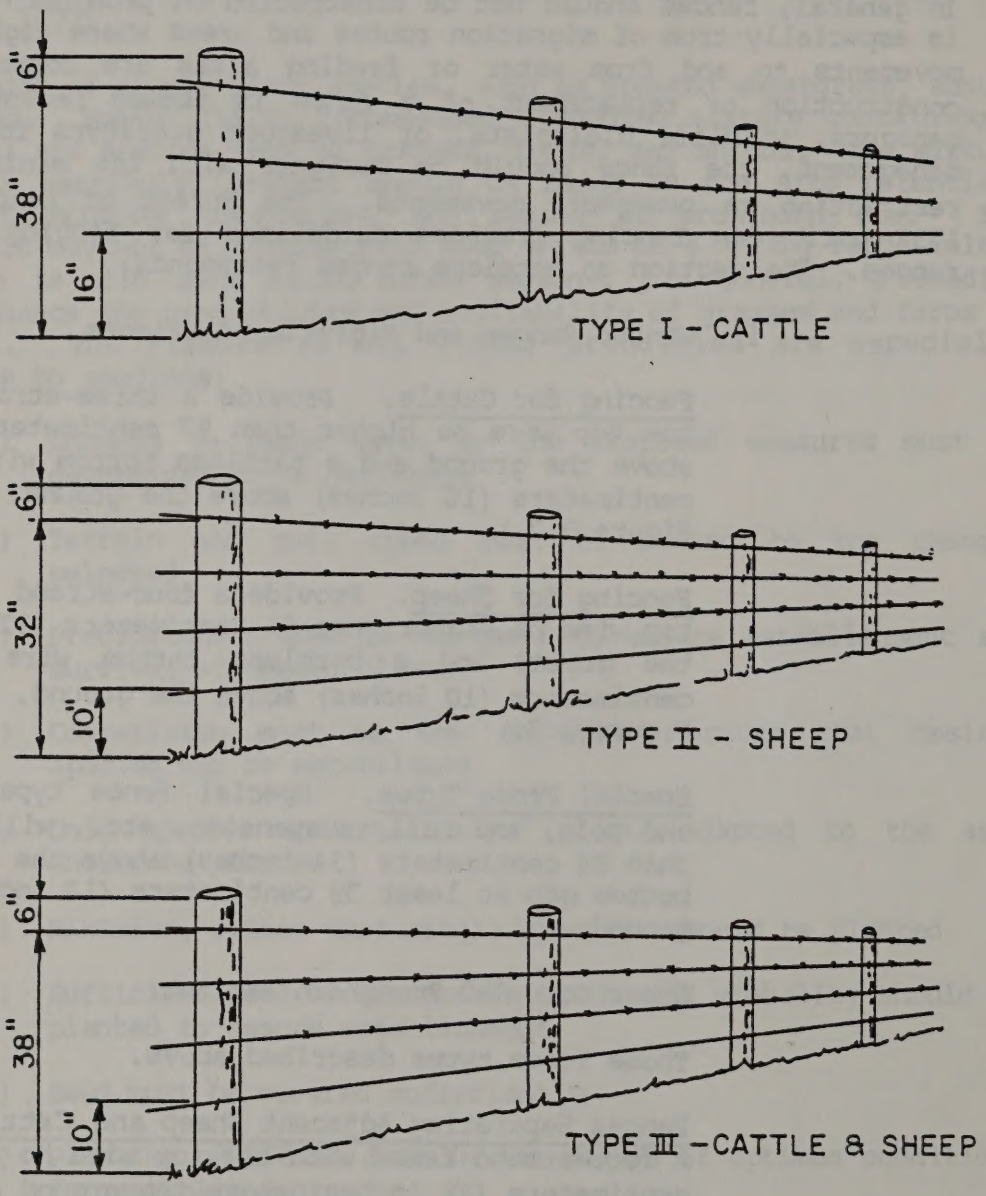


Figure 3-7. Recommended design for fences on pronghorn ranges (USDI Bureau of Land Management Manual 1737 - Fencing, Washington D.C. 17p).

3.10 Water

Kindschy et al. (1978) offered a detailed discussion of water management on pronghorn ranges. Pronghorns need up to 4.5 liters (1.2 gallons) of water per animal per day during the peak of summer (Sundstrom 1968). The water should have less than 4,500 ppm of dissolved solids (McKee and Wolf 1963). It should also have a pH of from 7.0 to 9.0. Other guidelines for water quality recommended by USFS Region 3 Interim Guidelines include:

	Maximum amount
Free chlorine	200 mg/L
Manganese	10 mg/L
Alkalinity (as $CaCO_3$)	50 mg/L
Chlorides	1,500 mg/L
Chromium	5 mg/L
Hardness	500 mg/L

Sundstrom (1968) found that 95 percent of over 12,000 pronghorn observations were within 6.5 kilometers (4 miles) of a water source. Yoakum (1978) recommended water distribution at 5-7 kilometers (3-4 miles) between sources. These must be permanent water sources. Springs, creeks, rivers, lakes, stock ponds, troughs, and guzzlers are all suitable.

Pronghorns can readily use areas when range fences allow movement under the bottom wire (photo by author).

4.0 MANAGEMENT OF HUMAN ACTIVITIES

4.1 Roads

Roads affect pronghorns in 3 principal ways: 1) they take up space that could be habitat, 2) they convey humans into pronghorn habitats, leading to potential harassment, and 3) they lead to automobile caused mortality. Road construction and maintenance should be minimized on pronghorn ranges. This is especially important on fawning areas, migration routes, and winter ranges. Unimproved roads are preferable to paved or all weather roads.

Where highways transect a pronghorn range, provision should be made to facilitate safe crossing by pronghorns. The use of fences to funnel deer into an underpass has resolved highway mortality problems. It may be used for pronghorns. New highways should be designed to bypass pronghorn ranges rather than cross them.

4.2 Buildings

Pronghorns become accustomed to buildings on their ranges. They are highly traditional, however, in the use of migration routes. Building construction on a traditional route when a similar alternate path is not available may effectively block movements or migration. If human activities are commonly associated with buildings, pronghorns may avoid the area. Consider these factors when assessing potential impacts of buildings on pronghorns:

i) degree of site importance to pronghorns

ii) alternative site availability

iii) level of human activity to be associated with buildings

4.3 Urbanization

Expansion of residential areas into pronghorn ranges can only cause problems for the animals. Harassment by humans is bound to increase. Unrestrained pet dogs will chase, if not kill, pronghorns. And, critical habitat is likely to shrink. Pronghorn habitats should receive zoning, prohibiting all but farm type human residences and developments that are compatible with pronghorns.

4.4 Industrial/Mining Developments

Discourage all industrial and mining developments on pronghorn ranges. When society chooses such developments over pronghorns, obtain mitigation through proper reclamation of the site or improvements on neighboring pronghorn habitats. Autenrieth (1978) covered the subject well.

4.5 Intermingled Private Lands

Where pronghorn ranges include private lands, work with the owners and managers to develop a coordinated plan for pronghorn management that addresses the role of those private lands. Compromises may be necessary to insure that land owners continue to provide pronghorn habitat. When private land owners change conditions such that pronghorns will suffer, work with all concerned citizens and agencies to modify herd management objectives and strategies accordingly.

4.6 Recreation

Encountering pronghorns on a day in the field adds quality to any recreational experience. Common exposure of people to wild pronghorns increases awareness and interest in the species. Some forms of recreation can be detrimental to pronghorns, however. Any actions which cause an animal to expend more energy than it would in normal daily activities increases the number of calories consumed. Each calorie relates to food that must be consumed. If excess quality forage is available, pronghorns may be able to replenish the loss. If such forage is unavailable, the energy loss will show up as depleted fatty tissue stores, i.e., lower condition. In general, the forage available during the late fall and winter is inadequate to allow weight gains. Any type of fall and winter harassment will, therefore, cause a condition decline. If harassment is common and prolonged, it can cause a severe loss in body condition and may be sufficient to cause malnutrition deaths during what would otherwise have been a normal winter. Management plans should prohibit all forms of human pursuit (e.g., aircraft, snowmobiles, trailbikes, etc.). Winter recreation should be limited to distant observations that do not cause the animals to run.

Bobcats are one of the predators on pronghorns. They usually prey upon fawns. (Photo by Jim Yoakum)

5.0 PREDATOR MANAGEMENT

Attitudes and understanding about the role of predators in pronghorn ecosystems have changed during the 20th century (Autenreith 1978). Pronghorn predators, principally the coyote and to a lesser degree the bobcat and eagle, are important members of the fauna. They prey on other herbivores, potential competitors, as well as pronghorns. In some instances, they may be significant in controlling pronghorn numbers, while in others they are an insignificant factor. There are often circumstances other than pronghorns that relate to predator management, e.g., livestock. All predator management programs for pronghorns should therefore be assessed on a local basis. There are no area-wide recommendations.

The intial step in evaluating predator management is to determine the effect of predation as a mortality factor on pronghorns. Habitat factors, such as cover and food, often lead to higher predation. If range resources are sufficient to support more pronghorns and predation is determined by scientific analysis of valid data to be the principal factor limiting attainment of population objectives, one can proceed to a consideration of predator management options:

i) Predation mortality often can be reduced by providing better quality habitats to pronghorns.

ii) High intensity predator control may be needed to effectively reduce predator densities (Connolly and Longhurst 1975).

iii) Predator reproduction can be stimulated by control efforts (Knowlton 1972).

iv) Effective control methods, may not be authorized for use on public lands.

v) Predators are a furbearer resource that society may wish to use.

vi) Benefits of extra pronghorns produced and used must offset the costs of predator control.

vii) Predator control must not conflict with objectives for other resources on the range.

6.0 DISEASE AND PARASITE MANAGEMENT

Epizootics as a factor controlling pronghorn populations are not common. Several diseases have been documented as mortality factors but none have

been considered to be problems in herd management. Among these are vibriosis (Trueblood and Post 1959) and epizootic hermorrhagic disease (Chalmers et al. 1964). Diseases must be treated on a local basis when outbreaks occur. Veterinarians and population ecologists should be consulted.

Parasites are common symbionts of pronghorns. They are not considered to be a problem in population management. Summary reports on pronghorn parasites are provided by Goldsby and Eveleth (1954), Honess and Winter (1956), and Boddicker and Hugghins (1969).

During fall and winter pronghorns are often observed in large groups on areas where sagebrush plants are above the snow pack. (Photo by author)

7.0 SUGGESTED RESEARCH NEEDS

Management of any wildlife resource rests on a foundation of knowledge about that resource. As management becomes more intensive, especially given the multi-resource milieu within which pronghorns reside, that information basis must be more complete. There are some important gaps in our knowledge of pronghorn ecology and pronghorn management strategies. Some of them can be resolved by well-designed research. We have partitioned these research needs into three categories:

i) Factors affecting pronghorn population dynamics, especially recruitment and density

ii) Population analysis and herd management

iii) Range/habitat analysis and management

Furthermore, we have ranked the topics within each category according to current importance to pronghorn management.

7.1 Factors Affecting Pronghorn Population Dynamics

The recruitment of yearlings into a population is the principal factor affecting density or herd size. The following research topics should, therefore be studied in relation to herd recruitment. The type of research needed on each topic is identified in parentheses. Descriptive research is needed when our basic knowledge of the topic is scant. We need to learn the "what and where" before explaining "why." Hypothesis testing research is indicated when we already know "what and where" fairly well. For example, we know that predators kill pronghorns and that predation can amount to a significant portion of annual mortality. We need to know how predation is related to habitat quality and how the interaction of the two ultimately effect recruitment. Hypothesis testing usually requires before and after comparisons. Research needs are:

i) Relationships of pronghorn densities to habitat type, seral stage, and ecological condition (descriptive research)

ii) Reproductive ecology in relation to ecological conditions and amounts of important seasonal ranges, intra- and interspecific competition (both interference and resource-use overlap), and annual weather (hypothesis testing)

iii) Effects of livestock grazing systems (species, numbers, and season of use) on pronghorn food habits, forage preference, and social structure in relation to recruitment and density (hypothesis testing)

iv) Role of feral horse populations in pronghorn ecology (both descriptive and hypothesis testing)

v) Predation in relation to habitat quality as a factor in recruitment and density (hypothesis testing)

vi) The role of developed wetlands in pronghorn recruitment and density (hypothesis testing)

vii) The effects of harvest strategies on social structure in relation to recruitment and density (hypothesis testing)

7.2 Population Analysis and Herd Management

These topics relate to our ability to manage populations more sensitively. That is, how can we better optimize pronghorn production for human uses?

i) Comparison of the statistical and biological validity of post-breeding herd structure censuses versus mid-summer censuses and of late winter herd trend counts versus mid-winter counts (descriptive research and hypothesis testing)

ii) Validation of simulation models used in herd management (hypothesis testing research)

iii) Extent and nature of dispersal between herd management units (descriptive research)

7.3 Range/Habitat Analysis and Management

These topics address our ability to better manage habitats and other resources on pronghorn ranges.

i) Development of habitat inventories for all range resources that provide sufficient information on which to base forage and space allocations among pronghorns and those other resources (descriptive research)

ii) Evaluation of the effects of livestock grazing management (species, numbers, and season of use) on pronghorn habitat characteristics (hypothesis testing)

iii) Evaluation of the responses of pronghorns to range improvements and mitigation for lost habitat (hypothesis testing)

iv) Development of range improvement designs that consider pronghorn social structure (descriptive research)

A new born pronghorn fawn in a low sagebrush vegetation type. (Photo by Jim Yoakum).

8.0 LIFE HISTORY/HABITAT NEEDS

8.1 Introduction

Pronghorn habitat needs differ seasonally as a function of the different phenomena in the annual life history cycle. Eight major categories are stressed: 1) forage use and preference, 2) water needs, 3) space and cover needs, 4) reproductive ecology, 5) growth and metabolism, 6) mortality, 7) movements and home range, and 8) social structure. Each of these is discussed in a general section on pronghorn ecology. This is followed by a season-by-season treatment, with pertinent literature references, and a narrative synthesis of knowledge about seasonal habitat preference.

8.2 Principles of Pronghorn Ecology

8.21 Forage Use and Preference

Pronghorns are opportunistic herbivores that select the most palatable and succulent forage available at any given time (Table 8-1). They are, by adaptation to Great Basin ecosystems, grazers of grasses and forbs from spring through mid-summer and browsers of rabbitbrush, sagebrush, bitterbrush, and cliff rose from mid-summer through winter. Use of grasses is generally limited to grazing of early spring grasses such as cheatgrass, Sandberg's bluegrass, Indian rice grass, and squirreltail. They also select cheatgrass during the fall and winter if precipitation favors fall germination. Forbs are the predominant forage during spring and summer when adults are recovering from winter stresses, when females are supporting fetal growth and lactation, and when young are growing. Ellis (1970) hypothesized that much of pronghorn population dynamics is related to the availability of forbs during these seasons. During late summer and the maintenance period of fall through winter, shrubs, especially sagebrush dominate the diet. Annual diets vary depending on the plants available in a specific area. The annual diet includes a high degree of forage switching from season to season (Figure 8-1).

8.22 Water Needs

Pronghorns obtain much of their water metabolically from succulent forage. This is especially true in spring. Standing or flowing water (free water) is needed, however, as ambient temperatures rise. Thus a pronghorn's need for free water increases from summer to fall (Beale 1966, Sundstrom 1968). Prior to human development of water

Table 8-1. Plants that comprise a significant portion of pronghorn antelope diets in the Great Basin (Beale and Smith 1970, Ferrel and Leach 1950, Mason 1952, Richardson 1972, Tsukamoto and Diebert 1969, and Yoakum 1958). Criteria for inclusion in this list are: 1) over 5% of any seasonal diet reported by volume or frequency of occurrence in diet, or 2) moderate or higher use reported from visual use estimates of any seasonal diet. Species with asterisks were reported as over 20% by volume or frequency, or as high use.

WINTER

Browses:	Forbs:	Grasses:
Artemisia arbuscula *	Balsamorhiza spp.	Bromus tectorum *
A. nova *	Eriogonum spp.	green grass *
A. tridentata *	Eriophyllum spp.	
Atriplex spinosa		
Eurotia confertifolia *	Helianthus spp.	
Chrysothamnus nauseosus	Phlox spp.	
C. viscidiflorus	Salsola kali	
Sarcobatus vermiculatus		

SPRING

Browses:	Forbs:	Grasses:
Artemisia nova *	Chaenactis macrantha *	Bromus tectorum *
A. spinescens *	Eriogonum spp. *	green grass *
A. tridentata *	Liliaceae *	Oryzopsis hymenoides
Purshia tridentata *	(Allium spp. ?)	
	Oenothera caespitosa *	Poa sandbergii *
Chrysothamnus nauseosus	Penstemon spp. *	Juncus spp.
C. viscidiflorus	Phlox spp. *	Sitanion hystrix
Ephedra nevadensis	Sphaeralcea spp. *	
Juniperus occidentalis	Astragulus spp.	
Prunus fasciculata	Collinsia spp.	
	Compositae	
	Cruciferae	
	Erigeron pumilus	
	Erodium cicutarium	
	Hymenopappus filifolius	
	Iva axillaris	
	Lomatium spp.	
	Rumex spp.	
	Trifolium spp.	

Table 8-1. Cont'd.

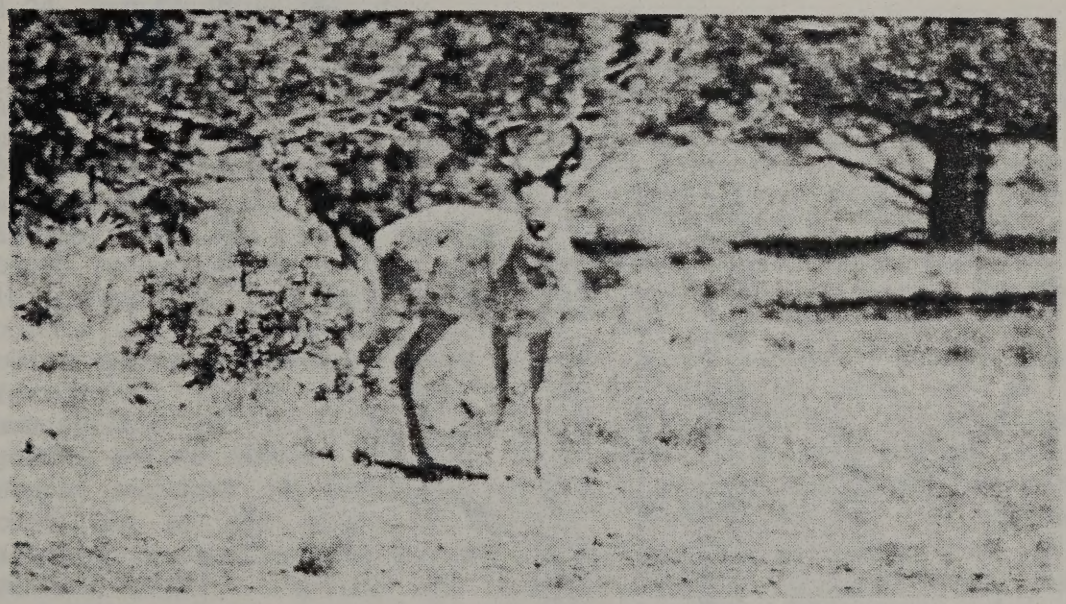
SUMMER

Browses:	Forbs:	Grasses:
Artemisia arbuscula *	Chaenactis spp.	green grass *
A. cana *	Chenopodiaceae *	Agropyron spp.
A. nova *	Erodium cicutarium *	Bromus spp.
A. tridentata *	Eriogonum spp. *	
Chrysothamnus viscidiflorus *	Euphorbia ocellata *	
Cowania stansburiana *	Iva axillaris *	
Pinus monophylla *	Linum lewisii *	
Prunus fasciculata *	Oenothera caespitosa *	
Purshia tridentata *	Opuntia spp. *	
Amelanchier alnifolia	Penstemon spp. *	
Arctostaphylos spp.	Phlox spp. *	
Brickelia oblongifolia	Polygonum spp. *	
Chrysothamnus nauseosus	Salsola kali *	
Ephedra nevadensis	Sphaeralcea spp. *	
Juniperus spp.	Agoseris spp.	
Symphoricarpos alba	Astragulus spp.	
S. longiflorus	Carum spp.	
Tetradymia spp.	Collinsia spp.	
	Comandra pallida	
	Compositae	
	Crepis spp.	
	Cruciferae	
	Descuriana spp.	
	Enceliopsis nudicaulis	
	Epilobium spp.	
	Erigeron austinae	
	E. pumilus	
	Eriophyllum spp.	
	Eryngium spp.	
	Euphorbia albomarginata	
	Gillia spp.	
	Helenium spp.	
	Lepidium montanum	
	Liliaceae	
	Lomatium spp.	
	Machaeranthera canescens	
	Medicago spp.	
	Monolepis spp.	
	Orthocarpos spp.	
	Oxytheca spp.	
	Plantago lanceolata	
	Ranunculus spp.	
	Townsendia florifer	
	Trifolium spp.	
	Valerianaceae	
	Viola spp.	
	Umbelliferae	

Table 8-1. Cont'd.

FALL

Browses:	Forbs:	Grass:
Artemisia nova	Erigeron austinae *	Bromus tectorum *
A. tridentata	E. pumilus *	green grass
A. arbuscula	Eriogonum spp. *	
Atriplex confertifolia	Iva axillaris *	
Brickelia oblongifolia	Linum lewisii *	
Chrysothamnus nauseosus	Oenothera tanacetifolia *	
C. viscidiflorus	Euphorbia ocellata *	
Juniperus occidentalis	Machaeranthera canescens *	
Prunus fasciculata	Sphaeralcea spp. *	
Purshia tridentata	Blepharipappus scaber	
	Chenopodiaceae	
	Compositae	
	Epilobium spp.	
	Eriophyllum spp.	
	Lactuca spp.	
	Lepidium spp.	
	Opuntia spp.	
	Polygonum aviculare	
	Rumex salicifolius	
	Salsola kali	
	S. pestifer	
	Townsendia florifer	



Pronghorns will use open stands of low growing sagebrush and herbs under an open canopy of trees. (Photo by author)

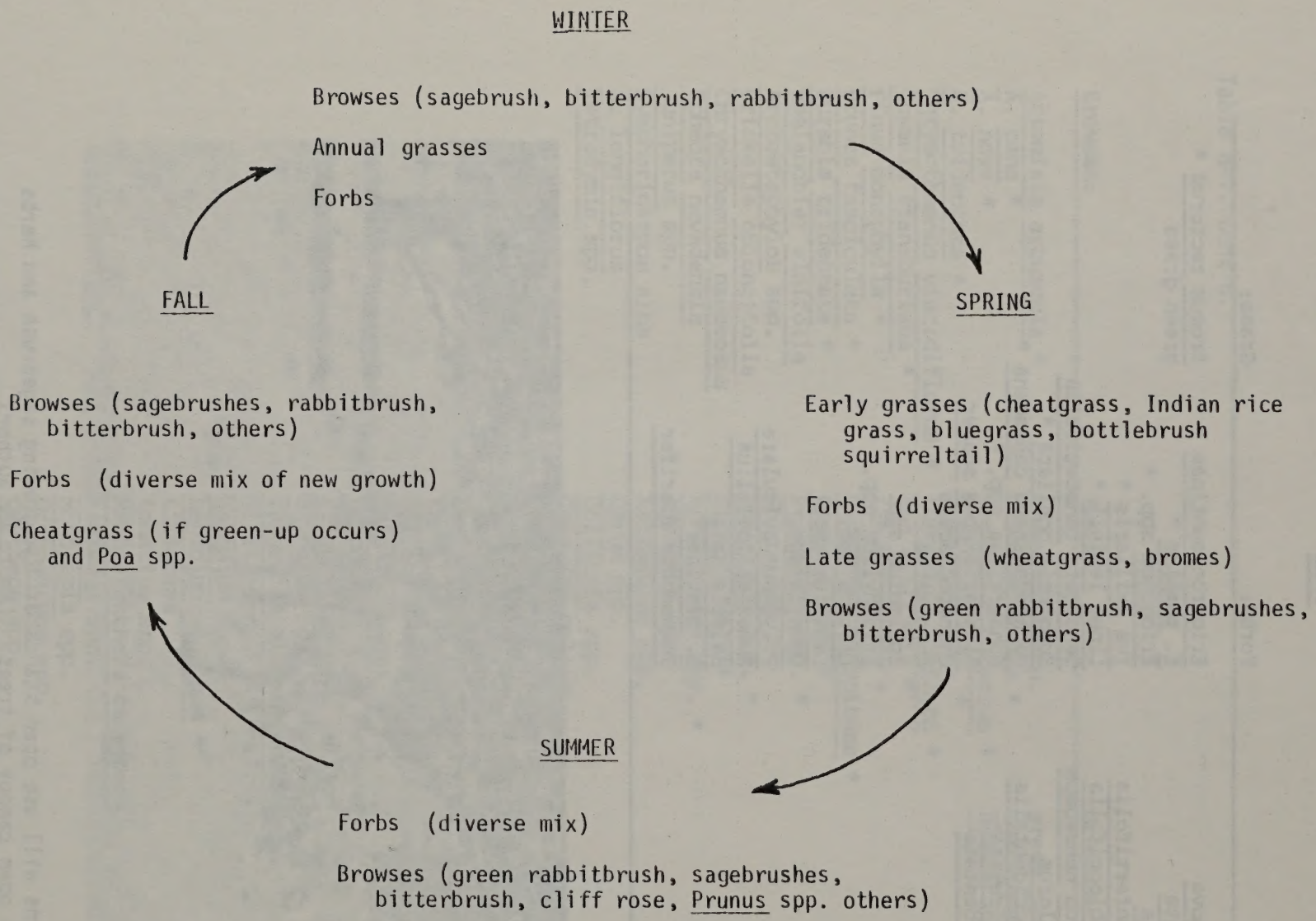


Figure 8-1. A general scheme of pronghorn diet switching

sources, pronghorns probably included natural stream basins and lakes in their home ranges. Following water developments, they may have colonized new habitats. Availability of free water in the summer and fall is certainly a factor in the pronghorn's ability to inhabit Great Basin ranges. Winter and early spring water requirements are probably met by moist forage and by available free water (they will eat snow). Yoakum (1978) recommended that free water be available every 5-7 kilometers (3-4 miles) on good pronghorn range. It should be relatively free of sediments (less than 5,000 ppm) and relatively neutral in pH (6.5-9.0).

8.23 Space and Cover Needs

Open space is a high-priority item in pronghorn habitat. Yoakum (1974) described the space needs generally as low, rolling, wide open, expansive terrain with slopes less than 30 percent. Pyrah (1974) and Autenrieth and Fichter (1975) described fawning cover needs and Bruns (1977) described winter cover uses. With the exception of fawning, little specific use is made of plant cover. They seem to rely on their physical attributes of excellent vision and speed for protection. It is known that pronghorns obtain thermal cover from their coarse, hollow hair. In addition, their herding instinct may provide for winter thermal cover from the sharing of body heat by members of a band.

8.24 Reproductive Ecology

The net measure of reproductive success is the number of yearlings added to a population through birth and fawn survival each year. The physiological condition of the breeding males and females will determine the number of young born each year, while nutrition plays an important role in fawn survival. Nutrition influences fetal develop-ment and growth through winter and spring, fawn vigor at birth is a function of late gestation growth. Post-natal survival is influenced by neo-natal fawn vigor, quantity of milk, weather conditions, diseases, accidents, and the net result of a multi-species predator-prey system. Following nursery band formation, fawns are less prone to mortality but are still susceptible to efficient predators, such as bobcats, coyotes, and golden eagles (Beale and Smith 1973, Bodie 1978, Von Gunten 1978). Winter survival of juveniles is influenced by their physiological condition at the onset of winter. Winter survival is further affected by weather severity and forage avail-ability (Martinka 1967, Pearson 1969). Vriend and Barrett (1978) indicated that fawn mortality may run as high as 80 percent during the period prior to weaning in the Great Basin.

Beale and Smith (1970) observed a fawn ratio of 181:100 females shortly after birth in southern Utah. Chattin and Lassen (1950) reported 35 embryos in 22 yearling and older females in California, a potential of 159 fawns per 100 females at birth. There is no reason to suspect other than an average 1:1 sex ratio of fawns born. Little work has been reported on annual fluctuation in fetal rates from wild herds. Yoakum (pers. commun.) suggests an average Great Basin fetal rate of 180:100 females.

Most states census age ratios in mid-summer. So, there are no data available on yearling recruitment rates. A simulation model of pronghorn in northeastern California, however, showed that an average recruitment of 38 new yearlings per 100 females allowed an annual 5 percent increase in the population. Additional simulations indicated that 32 new yearlings per 100 females was near the margin of exact replacement of annual adult losses. These estimated spring ratios would correspond to summer counts of 43 and 36 juveniles per 100 females respectively (Salwasser and Shimamoto 1979).

Reproductive success in pronghorns has been directly linked by several workers to favorable weather and range conditions (Beale and Smith 1970, 1973, Ellis 1970, Martinka 1967, Pearson 1969).

8.25 Growth and Metabolism

Pronghorns grow rapidly, 2-year olds having attained about 90 percent of the average size of mature adults (Mason 1952, Mitchell 1971). Eye-lens weights continue to increase throughout life (Kolenosky and Miller 1962). Bear (1971) documented an annual fat cycle in female pronghorns similar to that of mule deer.

Summer: Growth of juveniles, yearlings, and two year olds; tissue storage in yearlings and older adults.

Fall: Growth of juveniles, yearlings, and two year olds; tissue storage in all ages.

Winter: Tissue depletion in all ages.

Spring: Growth of juveniles and non-pregnant adults; tissue depletion in pregnant adults until after parturition.

Male pronghorns, on the other hand, showed a different pattern of continual slow growth through ages 5-6, with annual plateaus during winter-tissue depletion. As in deer, the males are slightly larger than females.

8.26 Mortality

Pronghorns have high reproductive rates. Consequently, stable populations also have relatively high mortality rates, about 50-75 percent among juveniles during the summer. This may be followed by a 10-30 percent winter juvenile mortality. Simulation models indicated that prime-aged adults (3-5 years old) had annual mortality rates of around 5-6 percent (Salwasser and Shimamoto 1979). It was not clear, however, whether seasonal mortality of adults was higher in summer or winter. Mortality increases as pronghorns approach age 7 and a 10-year old wild pronghorn is rare. Thus, mortality of 7 to 10 year olds may amount to 20 to 30 percent per year.

8.27 Movements and Home Ranges

Migration is the seasonal movement from one home range to another and back. Not all pronghorns are migratory. Some bands remain on a given range throughout the year, while others migrate to a distinct summer range. Migration is a traditional activity influenced by day length. Annual weather, however, does affect the onset of migrations.

Migratory bands usually begin spring movements as grasses begin to turn green. They follow the development of green grasses and forbs onto higher elevation summer ranges. Such a spring migration may last 4 to 8 weeks, depending on weather and snow conditions.

Fall migration is hastened by snowstorms that reduce forage availability on the summer range. In harsh years, pronghorn bands will concentrate on the most snow-free areas of their winter range. In mild weather years, on the other hand, some may not concentrate on the winter range remaining instead on snow-free parts of the summer range.

8.28 Social Structure

Pronghorns appear to have a definite seasonal social structure with well-defined hierarchies. While this has not been reported in the literature for Great Basin environments, it appears to be similar here to what has been observed in other areas. A mixed age and sex winter band exists from post-breeding in October to establishment of summer territories in April through May. During the territorial phase, dominant males defend an area that is frequented for varying periods by parturient does in May and by nursery bands of does and fawns from June to breeding in September. The nursery bands often move between male territories and are also dynamic with regard to the specific animals that occur in them at any time. Bachelor male bands of yearling to 3 year-old non-territorial males frequent the areas

between and at the margins of defended male territories. They may in fact occupy sub-optimum ranges. Each bachelor and nursery band has a definite hierarchy. See Prenzlow et al. (1968), Bromley (1969), Gilbert (1974), Kitchen (1974), and Autenreith and Fichter (1975) for their lucid discussions of pronghorn sociality.

8.3 Seasonal Life History/Habitat Requirement Model

8.31 Winter

A. Time: December through March: from concentration on the winter range to the start of movement to spring ranges.

B. Place: Winter Range (or Yearlong Range for Non-migrants)

C. Biological Events:

Reproduction

Fetal Growth: very slow through winter
(Hoover et al. 1959, Kolenosky and Miller 1962, O'Gara 1969)

Growth and Metabolism

Catabolism of Tissue Reserves: accelerates as winter progresses
(O'Gara and Greer 1970, Bear 1971)

Horn Sheath Regrowth: continues through winter
(O'Gara and Matson 1975)

Mortality

Juveniles: relatively high during late winter, may approach 25% in severe winters
(Yoakum 1957, Salwasser and Shimamoto 1979)

Adults: relatively low, directly related to snow depth
(Martinka 1967, Pearson 1969, Yoakum 1957, Salwasser and Shimamoto 1979)

Movements and Home Range

Movements are within traditional home ranges on relatively snow-free areas.

Social Structure

Winter Bands: mixed sexes and ages on traditional winter home ranges. (Einarsen 1948, Buechner 1950, Kitchen 1974, Autenrieth and Fichter 1975)

D. Habitat Needs:

Food (see Table 8-1)

Browses dominate, especially big sagebrush, silver sagebrush and rabbitbrushes. Cheatgrass and forbs are readily taken when green.

Water

We found no mention of winter water requirements in the literature. Apparently, pronghorns are capable of using water sources such as rain, snow, and ice. Winter temperatures and lack of body growth or lactation would make winter water needs the lowest of the annual cycle.

Space and Cover

Pronghorns require open areas where winds keep forage free of snow accumulations. Within this influence, however, they seek areas of lower wind velocities. Although they often bed in snow-free areas, they apparently do not use dense vegetation for cover, but engage in activity patterns that minimize heat loss (Bruns 1977).

E. Desired Habitat Structure:

Great Basin pronghorn winter ranges must have healthy productive diverse stands of low shrubs in mixed communities. These stands must coincide with the physiographic conditions that allow pronghorns to use them during periods of heavy snow. Yoakum (1974) listed criteria for year-long pronghorn range. On areas used exclusively as winter range or those portions of a year-long range where winter concentrations occur, vegetative criteria for management goals should be: 50 percent total vegetative cover composed of grasses (over 5 species ideal, 20-40 percent of vegetative cover), forbs (over 20 species ideal, 10-30 percent of vegetative cover), and shrubs (over 5 species ideal, 20-30 percent of vegetative cover). Such stands will allow pronghorns to select a diet of plants that has the potential to respond to favorable growth conditions

while still providing the staple browses needed during mid-winter. The range should be open, free of dense tree cover, and with shrubs under 40-50 cm (10-13 inches) in height. Fences should be minimized to allow animals free-use of their entire range. If it is a year-long pronghorn range, the patches of winter habitat should be interspersed with a diversity of other types of vegetative cover that will meet other seasonal needs.

8.32 Spring

A. Time: March to mid-June: from the start of spring movements to the formation of nursery bands following parturition.

B. Place: Spring Range (or Spring-use areas of Year-long Range)

C. Biological Events:

Reproduction

Fetal Growth: increasing throughout spring; peaks during last 4 weeks of gestation
(Hoover et al. 1959, Kolenosky and Miller 1962)

Parturition: Mid-May to mid-June
(Kautz 1942, McLean 1944, Einarsen 1948, Baker 1952, Folker 1956, Hoover et al. 1959, Wright and Dow 1962, Howard 1966, Kitchen 1974, Autenrieth and Fichter 1975)

Lactation: Parturition through summer
(Kautz 1942, Einarsen 1948, Gregg 1955, Folker 1956, Hoover et al. 1959, Davis 1960, Foree 1960, Fichter and Nelson 1962, Tileston 1962, Howard 1966, Prenzlow et al. 1968, Kitchen 1974, Autenrieth and Fichter 1975)

Growth and Metabolism

Male Tissue Replacement and Growth: entire season
(Kolenosky and Miller 1962, Bear 1971, Mitchell 1971)

Pregnant Females Tissue Catabolism: March to June
(Bear 1971)

Non-pregnant Females Tissue Replacement and Growth: entire season

Lactating Females Tissue Replacement: June
(Bear 1971)

Mortality

Adults: probably low due to high forage quality and an abundance of alternate prey for predators. Some highway deaths associated with migration possible. No literature on subject.

Fawns: very high during neo-natal period
(Beale and Smith 1973, Ellis 1970, Von Gunten 1978, Bodie 1978)

Movements and Home Range

Migration: March to early May: only for those bands that traditionally move between summer and winter home ranges.
(McLean 1944)

Social Structure

Migratory Bands of Mixed Sexes and Ages: March through arrival on summer ranges.
(Gilbert 1974, Kitchen 1974)

Male Territories: April through summer: begin on arrival on summer ranges.
(Gilbert 1974, Kitchen 1974)

Male Bachelor Bands: March through summer: begin as soon as territories form.
(Gilbert 1974), Kitchen 1974)

Solitary Parturient Females: May to early June: for 1 1/2 weeks around parturition.
(Kitchen 1974, Autenrieth and Fichter 1975)

D. Habitat Needs

Foods (See Table 8-1)

Pronghorns switch from winter browses to green grasses, especially cheatgrass, as soon as they appear. Sandberg's bluegrass and Indian ricegrass are other important early grasses. As soon as forbs appear, however, the animals decrease their use of grasses and switch to forbs. While a portion of the late spring diet is composed of browses and grasses, the diet on good

condition ranges is dominated by a diverse mix of forbs. As forb availability declines, pronghorns increase their use of green rabbitbrush and sagebrushes. Nutritionally, the longer pronghorns can stay on a forb diet in spring the better.

Water

Water is abundant on most spring ranges, both free water and metabolic water in succulent forage. Pronghorns may not need free water when forage exceeds 75 percent moisture content (Beale and Smith 1970). Total spring water needs are higher than winter needs because of higher ambient temperatures, tissue growth, and tissue replacement. Sundstrom (1968) reported water needs of about 0.5 liter daily in April. Daily needs rise as temperatures increase and forage dries. During parturition and lactation, habitat use by females is dependent on ready access to free water. Actual daily intake is related to the physiological status of the animal, ambient temperature, and availability of succulent forage.

Space and Cover

As in all seasons, open areas of low vegetation are preferred. As parturition approaches, females begin selecting fawning cover. Autenrieth and Fichter (1975) found fawning cover in stands of sagebrush that had greater than average brush cover, total cover, and mean shrub height. Pyrah (1974) found similar fawning cover uses, and listed suitable cover criteria:

Sagebrush	5 - 35% canopy cover
Grasses	15 - 40% canopy cover
Forbs	up to 30% canopy cover

A significant amount of successful fawning also occurs in low sagebrush habitats, and open grassy areas (Vriend and Barrett 1978).

E. Desired Habitat Structure:

Diversity, both within a particular stand of vegetation and between different stands, is a key to good pronghorn spring habitats. Open, expansive areas of relatively low growth form plants and few trees are preferred. Pronghorns actively seek a variety of foods as they become palatable and abundant. The habitat should provide this diet diversity through a high degree of interspersion. Silver

sagebrush stands offer a mix of plants as drier sites decline in forage availability. Burned areas and seeded stands (if seeded to a diverse plant mix) will contribute to spring habitat diversity. Meadows and vernal wetlands are important. It is desirable to have water within 2 kilometers (1 mile) of fawning habitats. Fences should be minimized.

8.33 Summer

A. Time: Late-June to September: from the formation of nursery bands to the start of breeding.

B. Place: Summer Range

C. Biological Events:

Reproduction

Lactation: entire season, declining toward late summer (Kautz 1942, Einarsen 1948, Gregg 1955, Folker 1956, Hoover et al. 1959, Davis 1960, Foree 1960, Fichter and Nelson 1962, Tileston 1962, Howard 1966, Prenzlow et al. 1968, Kitchen 1974, Autenrieth and Fichter 1975)

Weaning: begins in July, increasing toward late summer, generally completed by the start of breeding. (Einarsen 1948, Buechner 1950, Gregg 1955, Folker 1956, Prenzlow et al. 1968, Autenrieth and Fichter 1975)

Growth and Metabolism

Juvenile Growth: entire season
(Dow and Wright 1962, Kolenosky and Miller 1962, Wesley et al. 1970, 1973)

Adult Growth and/or Tissue Storage: entire season, begins as weaning progresses in lactating females
(Bear 1971, Wesley et al. 1973)

Horn Sheath Growth: through July
(O'Gara and Matson 1975)

Mortality

Juvenile: high in relation to forage availability and lactating doe condition. Predation is a factor throughout summer. Simulation modeling indicates a sex differential, 10 percent higher mortality on male fawns and an overall summer loss of up to 75 percent of both sexes.
(Beale and Smith 1973, Ellis 1970, Salwasser and Shimamoto 1979)

Adult: relatively low, 5 percent except for yearling females which are nursing for the first time and yearling males which are joining nomadic bachelor bands. Summer mortality may be high on older males which have lost their territories.
(Salwasser and Shimamoto 1979)

Harvest: usually occurs in late summer. Mortality varies according to hunting regulations. Wounding loss may approach 10-15 percent. Summer may be the season of highest illegal kill.
(Salwasser and Shimamoto 1979)

Movements and Home Range

Territorial males occupy home ranges.
(Kitchen 1974)

Bachelor male bands move between the boundaries of male territories.
(Kitchen 1974)

Nursery bands occupy larger home ranges that may include portions of more than one territorial male range.
(Kitchen 1974)

Social Structure

Male Territories: entire season
(Cole 1956, Cole and Wilkins 1959, Prenzlow et al. 1968, Bromley 1969, Gilbert 1974, Kitchen 1974)

Male Bachelor Bands: entire season
(Prenzlow et al. 1968, Kitchen 1974, Gilbert 1974)

Nursery Bands: entire season
(Prenzlow et al. 1968, Kitchen 1974, Autenrieth and Fichter 1975)

D. Habitat Needs:

Food (see Table 8-1)

Summer is marked by the highest diversity of plants in pronghorn diets. As in spring, forbs are important. Grasses, relatively unimportant in summer diets, are used lightly. Later grasses, such as wheatgrasses and bromes, may be used in summer. As forbs decline in availability, pronghorns switch to green rabbitbrush, sagebrushes, bitterbrush, and other browses. Browses sustain animals through late summer. Forbs and cheatgrass are used following late summer or fall rains. Heavy reliance on forbs (see Table 8-1) attests to the importance of wetlands in summer pronghorn habitats (Good and Crawford 1978).

Water

Free water becomes scarcer as summer progresses. Likewise, succulence of forage declines. Concurrently, higher ambient temperatures and lactation both raise an animal's need for free water. Pronghorns have been observed to remain near water sources or use more succulent forage on recently dried wetlands (Good and Crawford 1978). Taylor (1975) in a Wyoming study found 96 percent of all pronghorns within 5 kilometers (2.5 miles) of free water in summer. Beale and Smith (1970) observed increasing use of free water as the moisture content of forage fell below 75 percent. Yoakum (1974) suggested that summer water needs vary from 1 liter daily when forage is succulent to 6 liters per day when forage is dry. Sundstrom (1968) recommended free water sources within 6-8 kilometers (3-5 miles) of each other. Yoakum (pers. comm.) prefers water 2-4 kilometers (1-2 miles) apart.

Space and Cover

We found no literature on space or cover needs during summer. It is probably appropriate, however, to infer that general space and cover needs are as previously stated for pronghorn habitats in general.

E. Desired Habitat Structure:

Desired summer habitat differs from spring habitat only in the importance of meadows and wetlands. These vegetative types are not critical to good spring habitat because they are usually inundated. In the summer, however, they dry

and their fringes provide important sources of succulent forbs throughout the drying period. Vernal wetlands and short emergent marshes, drying sometime during the summer, should be interspersed within healthy diverse stands of shrubs, grasses, and forbs. Avoid creating wetlands out of fawning habitats. Wetlands should be created where they will add to the diversity of habitats, not replace one important habitat with another. Pronghorns use summer habitats in the general sequence: low and big sagebrushes, silver sage basins, vernal wetlands, back to low and big sagebrushes. All types should be present on each home range for optimum pronghorn performance. Water should be available on each home range at a minimum 4-6 kilometers (2-3 miles) apart. Fencing should be minimized because of the highly transient nature of the animals.

8.34 Fall

A. Time: September to late December: from the start of breeding to concentration on winter ranges

B. Place: Fall Range (Fall Areas of Yearlong Range)

C. Biological Activities:

Reproduction

Breeding: September to early October
(McLean 1944, Chattin and Lassen 1950, Hunter and Kinghorn 1950, Hoover et al. 1959, Wright and Dow 1962, Prenzlow et al. 1968, Bromley 1969, O'Gara 1969, Gilbert 1974, Kitchen 1974, Autenrieth and Fichter 1975)

Embryonic Development: implantation through December
(O'Gara 1969)

Growth and Metabolism

Juvenile Growth: rapid through November ?
(Hoover et al. 1959, Dow and Wright 1962, Kolenosky and Miller 1962, Mitchell 1971)

Adult Growth and/or Tissue Storage: through November ?
(Hoover et al. 1959, Dow and Wright 1962, Kolenosky and Miller 1962, Bear 1971, Mitchell 1971)

Horn Casting: October through December
(McLean 1944, Einarsen 1948, Hoover et al. 1959, Kitchen 1974, O'Gara and Matson 1975)

Mortality

All Ages and Sexes: probably relatively low as all animals are in peak physiological condition.
(Yoakum 1957, Bear 1971)

Movements and Home Range

Migration: October through December: only for bands that traditionally move between summer and winter home ranges.
(McLean 1944)

Social Structure

Male Territories: through the breeding period
(Bromley 1969, Gilbert 1974, Kitchen 1974)

Male Bachelor Bands: through the breeding period
(Bromley 1969, Gilbert 1974, Kitchen 1974)

Doe and Fawn Nursery Bands: through the breeding period
(Kitchen 1974, Autenrieth and Fichter 1975)

Winter Bands: mixed sex and age bands from breeding through winter
(Einarsen 1948, Buechner 1950, Kitchen 1974, Autenrieth and Fichter 1975)

D. Habitat Needs:

Food (see Table 8-1)

Pronghorns make increasingly heavy use of shrubs as fall progresses. Forbs are also heavily used if available and green, especially wetland forbs and buckwheats. Cheatgrass is an important fall food if green.

Water

Because of lower ambient temperatures and termination of the lactaton period, pronghorns require less water in fall than in the summer. Forage is still likely to be dry, however. So, some free water is essential in the habitat. Beale and Smith (1970) specify a 2 liter daily water need in October. Regardless of the exact daily need, free water is apparently required during the fall.

Space and Cover

Yoakum (pers. commun.) notes that pronghorns move to higher elevations and use trees for shade.

E. Desired Habitat Structure

Healthy diverse shrub and herbaceous stands intermixed with wetlands are optimum conditions for fall habitat. Sagebrushes are increasingly important browse. Sagebrush stands near water are probably key sites along migration routes. In general, follow the guidelines for summer habitat and ensure the presence of productive shrub stands.

9.0 LITERATURE CITED

Autenrieth, R.E. (ed.). 1978. Guidelines for the management of pronghorn antelope. in Barrett, M.W. (ed) Proc. of the Eighth Pronghorn Antelope Workshop. 8:472-526.

_____. and E. Fichter. 1975. On the behavior and socialization of pronghorn fawns. Wildl. Monogr. 42:1-111.

Baker, T.C. 1952. Experimental investigation in determining antelope distribution and movement. Wyo. Wildl. Res. Quart. Progr. Rept. 7:60-70.

Barrett, M.W. 1978. Proceedings of the eighth pronghorn antelope workshop. Alberta Recreation, Parks, and Wildlife, 532 p.

Beale, D.M. 1966. Big game - livestock relationship study. Utah Fish and Game Dept. Fed. Aid Rept. W-105-R.

_____. 1973. Mortality of pronghorn antelope fawns in Western Utah. J. Wildl. Manage. 37(3):343-352.

_____. and A.D. Smith. 1970. Forage use, water consumption, and productivity of pronghorn antelope in Western Utah. J. Wildl. Manage. 34(3):570-582.

Bear, G.D. 1969. Evaluation of aerial antelope census technique. Colo. Div. Wildl. Game Info. Leaflet No. 69:1-3.

_____. 1971. Seasonal trends in fat levels of pronghorns, Antilocapra americana, in Colorado. J. Mammal. 52(3):583-589.

Bell, R.H.V., J.J.R. Grimsdell, L.P. Van Lavieren, and J.A. Sayer. 1973. Census of the Kafue lechwe by aerial stratified sampling. E. Afr. Wildl. J. 11(1):55-74.

Boddicker, M.L. and E.J. Hugghins. 1969. Helminths of big game mammals in South Dakota. J. Parasitol. 55(5):1067-1074.

Bodie, W.L. 1978. Pronghorn fawn mortality in the upper Pahsimeroi River drainage of central Idaho. In: Barrett, M.W. (ed). Proc. of the Eighth Pronghorn Antelope Workshop. 8:417-428.

Bromley, P.T. 1969. Territoriality in pronghorn bucks on the National Bison Range, Morese, Montana. J. Mammal. 50(1):81-89.

Bruns, E.H. 1977. Winter behavior of pronghorns in relation to habitat. J. Wildl. Manage. 41(3):560-571.

Buechner, H.K. 1950. Life history, ecology and range use of the pronghorn antelope in Texas. Am. Midl. Nat. 43(2):257-354.

Burkhardt, J.W. and E.W. Tisdale. 1976. Causes of juniper invasion in Southwestern Idaho. Ecol. 57(3):472-484.

Caughley, G. 1974. Bias in aerial survey. J. Wildl. Manage. 38(4):921-933.

_____. 1977a. Analysis of vertebrate populations. John Wiley and Sons. New York 234 p.

_____. 1977b. Sampling in aerial survey. J. Wildl. Manage. 41(4):605-615.

Chalmers, G.A., H.N. Vance, and G.J. Mitchell. 1964. An outbreak of epizootic hemorrhagic disease in wild ungulates in Alberta. Wildl. Dis. 42:1-6.

Chattin, J.E. and R. Lassen. 1950. California antelope reproductive potentials. Calif. Fish and Game. 36(3):328-329.

Cole, G.F. 1956. The pronghorn antelope, its range use and food habits in Central Montana with special reference to alfalfa. Montana State Coll. Agric. Exp. Sta. Tech. Bull. 516:62 p.

_____. and B.T. Wilkins. 1958. The pronghorn antelope, its range use and food habits in Central Montana with special reference to wheat. Montana Fish and Game Dept. Tech. Bull No. 2:39 p.

Cole, L.C. 1957. Sketches of general and comparative demography. Cold Springs Harb. Symp. Quant. Biol. 22:1-15.

Connolly, G.E. and W.M. Longhrust. 1975. The effects of control on coyote population: a simulation model. Univ. Calif. Div. Agric. Sci. Bull. 1872. 32 p.

Davis, W.E. 1960. The mammals of Texas. Texas and Fish Comm. Bull. 41:252 p.

Dow, S.A. and P.L. Wright. 1962. Changes in mandibular dentition associated with age in pronghorn antelope. J. Wildl. Manage. 26(1):1-18.

Eberhardt. L.L. 1978a. Transect methods for population studies. J. Wildl. Manage. 42(1):1-31.

_____. 1978b. Appraising variability in population studies. J. Wildl. Manage. 42(2):207-238.

Einarsen, A.S. 1948. The pronghorn antelope and its management. Wildl. Manage. Inst. 235 p.

Ellis, J.E. 1970. A computer analysis of fawn survival in the pronghorn antelope. Ph.D. Dissertation Univ. Calif. Davis. 67 p.

Ferrel, C.M. and H.R. Leach. 1950. Food habits of the pronghorn antelope of California. Calif. Fish and Game. 36(1):21-26.

Fichter, E. and A.E. Nelson. 1962. Study of pronghorn population. Idaho Dept. of Fish and Game Fed. Aid to Wildl. Rest. Rept. W85-R-13:17 p.

Folker, R.V. 1956. A preliminary study of antelope herd in Owyhee County, Idaho. M.S. Thesis, Univ. Idaho, Moscow. 102 p.

Foree, W.W. 1960. Nevada antelope studies - progress report. Trans. Interstate Antelope Conf. 11:58-82.

Gilbert, B.K. 1974. Scent marking and territoriality in pronghorn (Antilocapra americana) in Yellowstone National Park, Extrait de Mammalia. 37(1):25-33.

Goldsby, A.I. and D.F. Eveleth. 1954. Internal parasites in North Dakota antelope. J. Parasito. 40(6):637-648.

Good, J.R. and J.A. Crawford. 1978. Factors influencing pronghorn use of playas in south central Oregon. In: Barrett, M.W. (ed). Proc. of the Eighth Pronghorn Antelope Workshop. 8:182-205.

Gregg, H.A. 1955. Summer habits of Wyoming antelope. Ph.D. Dissertation. Cornell Univ. 185 p.

Heady, H.F. 1975. Rangeland management. McGraw-Hill Book Co. New York. 460 p.

_____. and J. Bartolome. 1977. The Vale rangeland rehabilitation program: the desert repaired in Southeastern Oregon. USDA For. Serv. Resour. Bull. PNW-70, 139 p.

Honess, R.F. and K.B. Winter. 1956. Diseases of wildlife in Wyoming. Wyo. Game and Fish Comm. Bull. No. 9:279 p.

Hoover, R.L., C.E. Till, and S. Ogilvie. 1959. The antelope of Colorado. Colo. Dept. Fish and Game Tech. Bull. No. 4:110 p.

Howard, V.W. 1966. An observation of parturition in the pronghorn antelope. J. Mammal. 47(4):708-709.

Hunter, G.N. and R.G. Kinghorn. 1950. Montana records of antelope embryos and reproductive tracts. J. Mammal. 31(2):192-193.

Jolly, G.M. 1969. Sampling methods for aerial censuses of wildlife populations. E. Afr. Agric. For. J. 34 (special issue):46-49.

Kautz, L.G. 1942. Antelope survey. Colo. Wildl. Res. Quart. Progr. Rept. 8:1-26.

Kindschy, R.R. 1974. Preliminary report on nomad alfalfa seedings. USDI Bur. Land Manage. Vale, Oregon Special Rept. 19 p.

_____., C. Sundstrom, and J. Yoakum. 1978. Range/Wildlife interrelationships—pronghorn antelope. In: Barrett, M.W. (ed). Proc. of the Eighth Pronghorn Antelope Workshop. 8:216-262.

Kitchen, D.W. 1974. Social behavior and ecology of the pronghorn. Wildl. Monogr. 38:96p.

Knowlton, F.F. 1972. Preliminary interpretations of coyote population mechanics with some managerial implications. J. Wildl. Manage. 36(2):369-382.

Kolenosky, B. and R.S. Miller. 1962. Growth of the lens of the pronghorn antelope. J. Wildl. Manage. 26(1):112-113.

Martinka, C.J. 1967. Mortality of Northern Montana pronghorns in a severe winter. J. Wildl. Manage. 31(1):159-164.

Mason, E. 1952. Food habits and measurements of Hart Mountain antelope. J. Wildl. Manage. 16(3):387-389.

McKee, J.E. and H.W. Wolf. 1963. Water quality criteria. Calif. State Water Quality Control. Pub. No. 3-4:548 p.

McLean, D.D. 1944. The pronghorned antelope in California. Calif. Fish and Game. 30(4):221-241.

Mitchell, G.J. 1971. Measurements, weights, and carcass yields of pronghorns in Alberta. J. Wildl. Manage. 35(1):76-85.

Norton-Griffiths, M. 1973. Counting the Serengeti migratory wildebeest using two-stage sampling. E. Afr. Wildl. J. 11(2):135-149.

O'Gara, B.W. 1969. Unique aspects of reproduction in the female pronghorn (Antilocapra americana Ord). Am. J. Anat. 125(2):217-231.

_____. and K.R. Greer. 1970. Food habits in relation to physical condition in two populations of pronghorns. Proc. of the fourth Proghorn Antelope Workshop 4:131-139.

_____. and G. Matson. 1975. Growth and casting of horns by pronghorns and exfoliation of horns by bovids. J. Mammal. 56(4):829-846.

Paulik, G.J. and D.S. Robson. 1969. Statistical calculations for change-in-ratio estimators of population parameters. J. Wildl. Manage. 33(1):1-27.

Pearson, H.A. 1969. Starvation in antelope with stomachs full of feed. USDA For. Ser. Res. Note RM-148:4 p.

Plummer, A.P., D.R. Christensen, and S.B. Monsen. 1968. Restorating big-game range in Utah. Utah Div. Fish and Game. Pub. No. 68-3:183 p.

Prenzlow, E. J., D.L. Gilbert, and F.A. Glover. 1968. Some behavior patterns of the pronghorn. Colo. Dept. Game, Fish and Parks Special Rept. No. 17:16 p.

Pyrah, D.B. 1974. The relationship of vegetation type to the distribution of antelope; fawn bedding cover. Montana Dept. Fish and Game Fed. Aid. to Wildl. Rest. W-105-R-09:17 p.

Richardson, J.L. 1972. Antelope status report; Sheldon-Hart Mountain National Antelope Refuges and Charles Sheldon Antelope Range. Trans. Interstate Antelope Conf. 7 p.

Salwasser, H. 1979. The ecology and management of the Devil's Garden Interstate mule deer herd and its range. Ph.D. Dissertation. Univ. Calif. Berkeley. 377 p.

_____. and T.M. Pojar. Simulation modeling of pronghorn populations, ms. in prep.

_____. and K. Shimamoto. 1979. Some aspects of pronghorn ecology and management in northeastern California. Trans. West. Sect. Wildl. Soc. (in press).

_____., J.C. Capp, H. Black, Jr., and J.F. Hurley. 1980. The California wildlife habitat relationships program: an overview. In: R.DeGraff (ed). Proc. Workshop Manage. Western Forests and Grasslands for Nongame Birds. USDA For. Serv. Gen. Tech. Rept. IM Station. in print.

Seber, G.A.F. 1973. The estimation of animal abundance and related parameters. Griffen, London. 506 p.

Siniff, D.B. and R.O. Skoog. 1964. Aerial censusing of caribou using stratified random sampling. J. Wildl. Manage. 28(2):391-401.

Smith, M.H., and H.O. Hillestad, M.N. Manlove, and R.L. Marchinton. 1976. Use of population genetics data for the management of fish and wildlife populations. Trans. North Am. Wildl. and Nat. Resour. Conf. 41:119-133.

Sundstrom, C. 1968. Water consumption by pronghorn antelope and distribution related to water in Wyoming's Red Desert. Antelope States Workshop Proc. 3:39-46.

Taylor, E.R. 1975. Pronghorn carrying capacity of Wyoming's Red Desert. Wyo. Game and Fish Dept. Wildl. Tech. Rept. No. 3:65 p.

Thomas, J.W. and C. Maser. Wildlife habitats in managed rangelands--the Great Basin of southeastern Oregon. in progress.

Tileston, J.V. 1962. A resume of Colorado big game research projects, 1939-1957. Colo. Game and Fish Dept. Tech. Bull. 9:81 p.

Trueblood, M.S. and G. Post. 1959. Vibriosis as a factor in the reproduction of antelope (Antilocapra americana). J. Am. Veter. Medical Assn. 134(12):562-564.

Tsukamoto, G. and W. Diebert. 1969. A preliminary report of Nevada pronghorn antelope food habits during August and September. Trans. Interstate Antelope Conf. 19:7-13.

Vale, T.R. 1975. Presettlement vegetation in the sagebrush-grass area of the intermountain west. J. Range Manage. 28(1):32-36.

Von Gunten, B.L. 1978. Pronghorn fawn mortality on the National Biosin Range. In: Barrett, M.W. (ed). Proceedings of the Eighth Biennial Pronghorn Antelope Workshop. 8:394-416.

Vriend, H.G. and M.W. Barrett. 1978. Low pronghorn recruitment--is it an issue? In: Barrett, M.W. (ed). Proceedings of the Eighth Biennial Pronghorn Antelope Workshop. 8:360-379.

Wesley, D.E. 1973. Energy metabolism of pronghorn antelope. J. Wildl. Manage. 37(4):563-573.

_____., K.L. Knox, and J.G. Nagy. 1970. Energy flux and water kinetics in young pronghorn antelope. J. Wildl. Manage. 34(4):908-912.

_____. 1973. Energy metabolism of pronghorn antelope. J. Wildl. Manage. 37(4):563-573.

Wright, P.L. and S.A. Dow. 1962. Minimum breeding age in pronghorn antelope. J. Wildl. Manage. 25(1):100-101.

Yoakum, J. 1957. Factors affecting the mortality of pronghorn antelope in Oregon. M.S. Thesis. Oregon State Univ. 112 p.

_____. 1958. Seasonal food habits of the Oregon pronghorn antelope (Antilocapra americana oregona Bailey). Trans. Interstate Antelope Conf. 9:47-59.

_____. 1972. Antelope-vegetative relationships. Proc. of the Fifth Pronghorn Antelope Workshop. 5:171-177.

_____. 1974. Pronghorn habitat requirements for sagebrush-grasslands. Proc. of the Sixth Pronghorn Antelope Workshop. 6:16-25.

_____. 1975. Antelope and livestock on rangelands. J. Anim. Sci. 40(5):985-992.

_____. 1978. Managing rangelands for the American pronghorn antelope. In: Barrett, M.W. (ed). Proc. of the Eighth Pronghorn Antelope Workshop. 8:321-336.

While this adult male pronghorn died of disease, a bobcat "claimed" the carcass and partly covered it. Careful examination is needed to distinguish between predation and scavenging. (Photo by Rodney P. Canutt).

APPENDIX A. Scientific Names of Plants Cited

Sagebrush	*Artemisia* spp.
Big Sagebrush	*A. tridentata*
Low Sagebrush	*A. arbuscula*
Silver Sagebrush	*A. cana*
Bitterbrush	*Purshia tridentata*
Green Rabbitbrush	*Chrysothamnus viscidiflorus*
Cliff Rose	*Cowania stansburiana*
Buckwheat	*Eriogonum* spp.
Cheatgrass	*Bromus tectorum*
Bottlebrush squirreltail	*Sitanion hystrix*
Indian rice grass	*Oryzopsis hymenoides*
Wheatgrass	*Agropyron* spp.